VOLUME 17, NO. 9 SEPTEMBER, 1938

REFINER
AND NATURAL GASOLINE MANUFACTURER

A GULF PUBLISHING COMPANY PUBLICATION

The Look Box

THE concentration of the natural gasoline capacity in fewer hands and fewer units, which first became evident about 1929, was continued in 1936 and 1937. This fact is indicated by the recently issued Information Circular 7031, "Natural Gasoline Plants in the United States, January 1, 1938," published by the Bureau of Mines. This survey indicated a total of 741 plants as of that date compared with 793 on January 1, 1936, and 1155 on January 1, 1928. Of the 741 plants on January 1, 1938, 679 were operating and only 62 were closed down. The dismantling of at least 50 relatively small plants in Oklahoma and Illinois was largely responsible for the decline in number of plants in 1936 and 1937. Texas and New Mexico were virtually the only states in which the number of plants increased during the 2-year period.

Natural Gasoline

Despite the material decline in number of plants, the total capacity on January 1, 1938, was not much more than it was on January 1, 1929. This was because nearly all of the new plants were large, whereas most of the plants torn down were small. Another consideration was the enlargement of plants by the addition of new units. The total capacity of all the plants on January 1, 1938, was 11,083,000 gallons daily, of which all but 351,000 gallons (3 percent) was at operating plants. However, the operating plants ran at not quite 60 percent of capacity in 1937. Texas had about a third of the operating capacity on January 1, 1938, California about 30 percent, and Oklahoma slightly more than 20 percent. About half of the gain in daily operating capacity in 1936 and 1937 of 1,689,000 gallons was credited to Texas. Furthermore, nearly half of the increase in Texas was in the two leading districts, Panhandle and East Texas. It was expected that the elimination of "stripping" in the Panhandle would reduce the total capacity, but actually the total capacity increased from about 1,300,000 gallons daily on January 1, 1936, to about 1,450,000 gallons daily on January 1, 1938. The capacity in the East Texas field increased from about 425,000 gallons daily, on January 1, 1936, to about 615,000 gallons on January 1, 1938. This gain resulted primarily from a gain in the number of producing oil wells from 19,520 on January 1, 1936, to about 25,000 on January 1, 1938, although competition of gasoline manufacturers for casinghead gas from the older wells was probably also a factor.

Although the number of absorption plants continued to decline, the total capacity increased materially in 1936 and 1937. Plants using the compression process, the other major type, declined both in number and total capacity. The charcoal process, supposedly too expensive to operate at the relatively low prices of recent years, maintained its relative position in 1936

and 1937; in fact a small rise in capacity was reported.

The report shows a total of 679 operating plants and 62 shut down, or a total of 741, and of this number 416 were absorption plants, 283 were compression plants, 31 were combination absorption-compression and 11 were charcoal plants. Texas led with 135 operating installations, Oklahoma was second with 133 plants and California reported 93 plants. In operating capacity, Texas was first with 3,471,000 gallons daily capacity, California was second with 3,437,000 gallons, and Oklahoma third with daily capacity of 2,359,000 gallons.

Plans for a wide variety of construction of new projects and for the expansion and modernization of present facilities have been made by many of the large gasoline manufacturers. Much of this work has been held up pending development of a more favorable outlook. It is known, however, that most of the more aggressive manufacturers are ready to take advantage of the recent developments in technology and engineering, as is indicated by inquiries now in the hands of engineering contractors and various equipment manufacturers. Not only is there to be increased activity in the natural gasoline plants as now designed and operated but there is to be marked activity in the installation of the recently developed gas-recycling-gasoline extraction - formation - repressuring type of plant, and in the regions where "distillate" wells are found, a plant of special design is to be employed for recovery of the distillate and repressuring of the producing formation, which should prove a profitable operation.

By-Products

THE commercial value of the by-products from petroleum has kept pace with their research and development. Many industries, such as textile, solvents, explosives, and others are benfiting from the latter developments in the manufacture of synthetic products. The trend of the past few years has been toward synthesis along main-product as well as by-product lines, as evidenced in the manufacture of the super motor fuels coming into use in the airplane carriers of today.

"The hydrocarbons from cracking, particularly the olefin gases, have, on account of their abundance and reacting power, generally been the foundations of the synthesizing processes. Polymerization in the presence of catalysts forms motor fuels, lubricating oils, and rubber-like substances. The olefin gases are used as alkylating agents for aromatic hydrocarbons, phenols, and, more recently, paraffins. They are also the starting materials for the preparation of alcohols and other solvents, and for the halogenated and sulfonated products finding extensive use as both intermediates and final compounds. The higher-boiling fractions are practically as available as the gaseous ones and the reactions possible for converting them into synthetic products, while differing in degree and mechanism, as essentially the same—hydration, isomerization, cyclization, polymerization, depolymerization, hydrogenation, and dehydrogenation."—*From "The Cracking Art in 1937," Universal Oil Products Company Bulletin No. 225, compiled by Egloff, Doty and Jordan.*

Wax to Soap

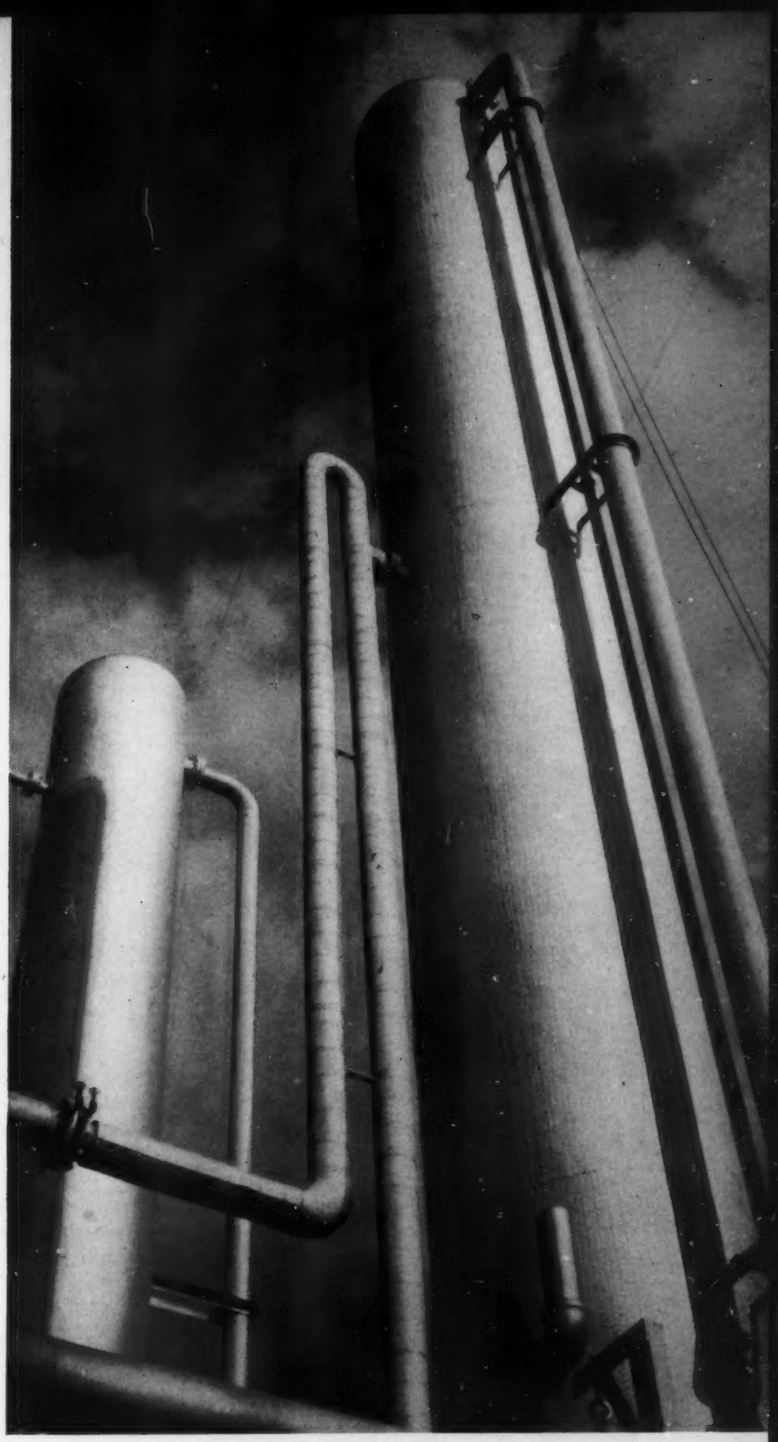
THE solid hydrocarbons of the paraffin-wax fraction derived from some crudes have been subject to much research and development work during recent years. Many things have been done with it in several organizations. One of the most interesting, however, is that process where some of the hydrogen is taken away from it, then oxidizing the material. Distillation then yields products similar to those obtained from fats (palmitic and stearic acid) which serve for the manufacture of soap. It is practiced to some extent in Germany, and in a commercial unit at Baton Rouge, Louisiana, of 15 tons capacity. And at the latter refinery, working under I. G. Farbenindustrie patents as well as Standard Oil Company of New Jersey rights, selected waste gases from the refining operation are forced through the electric arc where conversion to acetylene takes place. Acetylene is then oxidized to acetaldehyde and then to acetic acid, using special catalysts. Vinegar, soap, butter-fat, resins, alcohols, ketones, dyes, detergents and wetter-water and a wide range of other products are now being synthetically produced in this country. And the petroleum technologist has only scratched the surface. There are interesting days ahead with new processes, new technique, new horizons.

New Crude

THE crude oil produced from the deep K-M-A pay horizon (Strawn formation) in Wichita and Archer Counties, Texas, is an intermediate base oil having a gravity of 43.8° A.P.I. and a sulfur content of 0.21 percent, according to an analysis made by the Bureau of Mines, on a sample obtained from the Kadane et al Mangolf 1-A well, which was completed during November, 1937, at 3752 feet. The crude is greenish brown in color and on distillation the first drop is received at 86° F.

The analysis shows a recovery of 15.6 percent of 77.2° A.P.I. gravity light gasoline. Total gasoline and naphtha is 40.8 percent with gravity of

[*Continued on page 492*]



Modern Design Features Add to Efficiency of

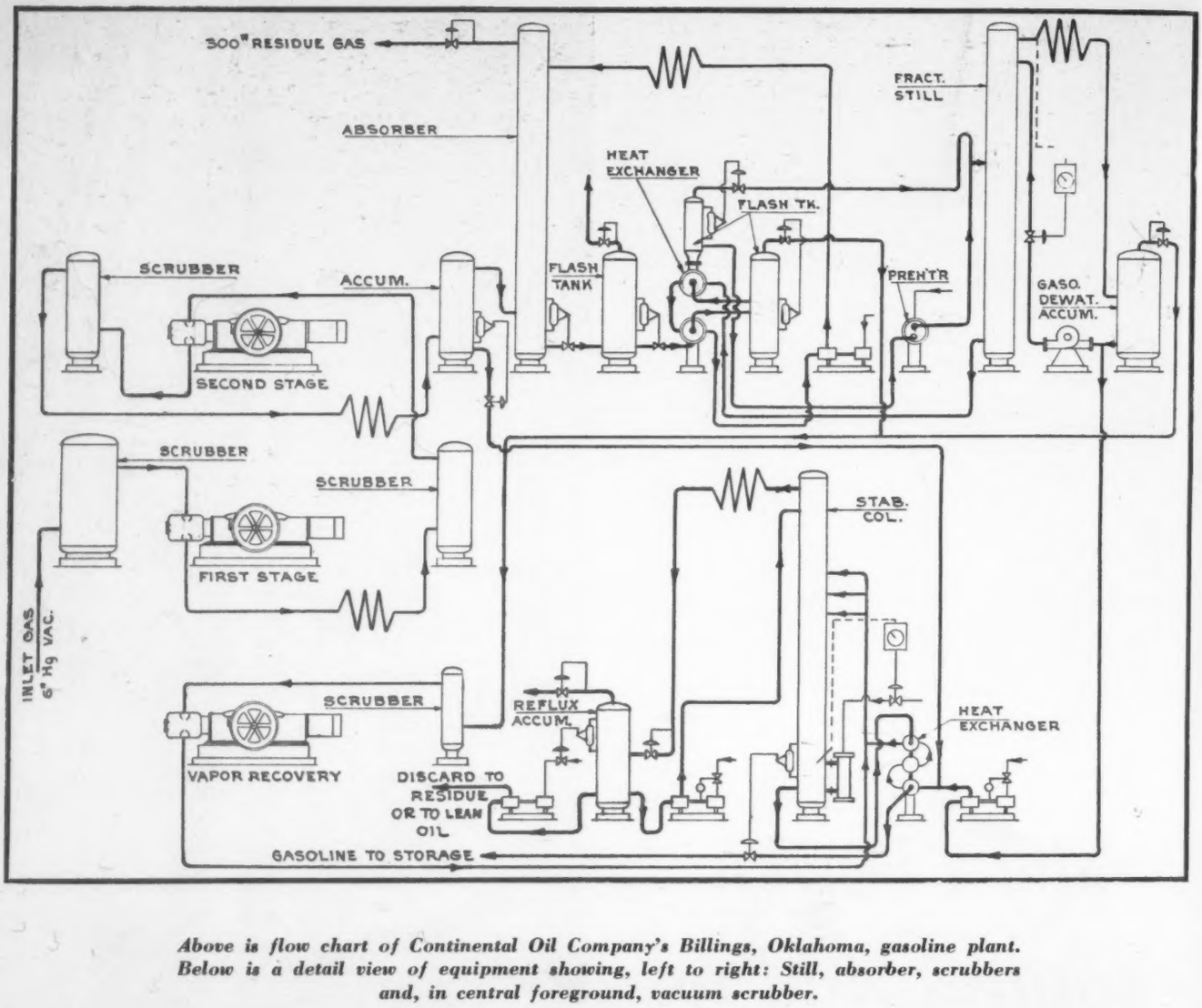
Billings Gasoline Plant

OPERATED by Continental Oil Company, and owned jointly by that company and Phillips Petroleum Company, Shell Petroleum Corporation, and the Tide Water Associated Oil Company, a new natural gasoline plant has recently been placed in operation at Billings, Noble County, Oklahoma. This plant, built to handle all casinghead and separator gas produced in the area, was erected as a turn-key job with The Stearns-Roger Manufacturing Company, Denver, Colorado, and Parkhill-Wade, Los Angeles, California, in charge of engineering, design and construction.

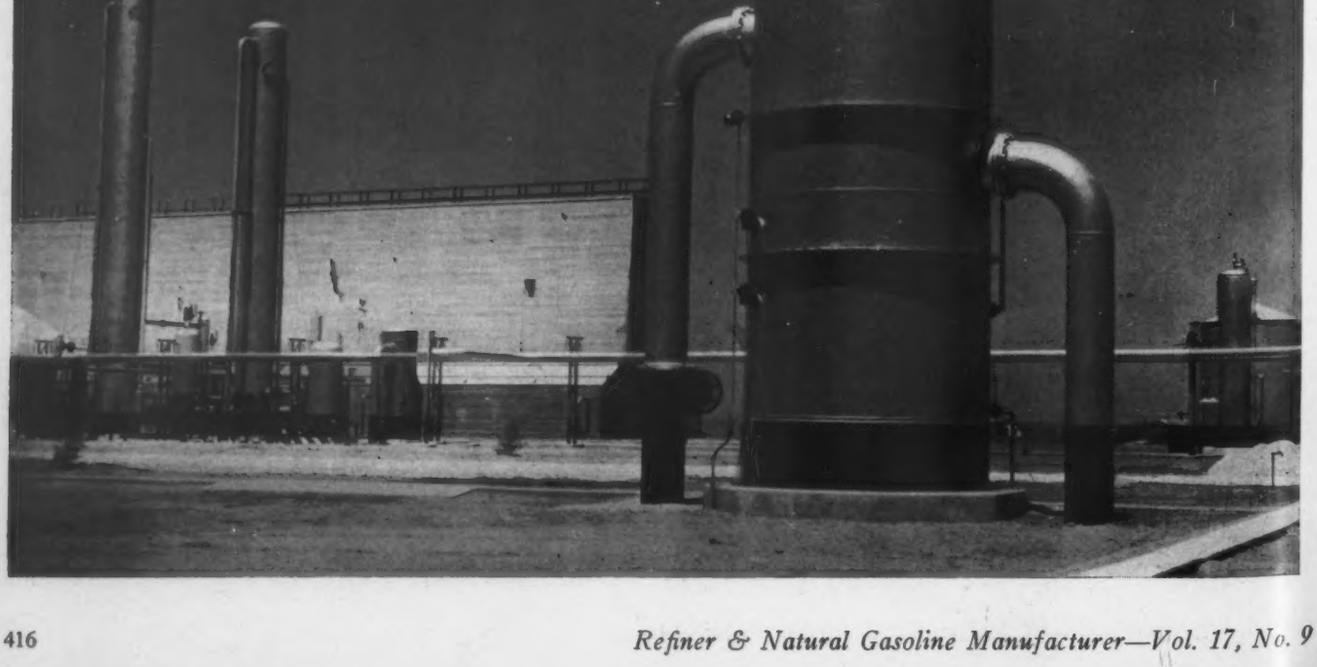
The site selected for the plant is as ideal as can be obtained in a treeless, windy country and it offers several distinct advantages. The plant yard grade is several feet above most of the producing wells and this prevents a large amount of fluid from flowing into the scrubbers if a well should run wild above separator capacity. Because of the natural advantages of the site, drainage of waste water is easily cared for with the plant sewer lines leading to a common receiver pond naturally by gravity. The wind of the open country eliminates a fire hazard which might occur by settling of heavy vapors escaping from safety valves when, as and if they are required to operate.

COMPRESSION AND ABSORPTION

The plant design incorporates both compression and



Above is flow chart of Continental Oil Company's Billings, Oklahoma, gasoline plant. Below is a detail view of equipment showing, left to right: Still, absorber, scrubbers and, in central foreground, vacuum scrubber.



General view of the Billings plant.

absorption extraction of natural gasoline, utilizing two stages of compression to obtain efficient absorption extraction and the required pressure on residue gas from the absorption system. Low-pressure gas removal is obtained from traps by maintaining a close regulation of pressure which averages approximately 2 inches Hg. vacuum with a back pressure held on pumping wells to assist in lifting the oil economically. Nine twin cylinder, horizontal, four-cycle, 225 horsepower gas engines are used to handle the gas, eight of which are equipped with high- and low-pressure compressor cylinders. The remaining engine is divided between high-pressure gas delivery and vapor-recovery service, one cylinder receiving gas from vent tanks and other vessels, delivering it to the fractionator for extraction of all desirable gasoline fractions.

Gas from traps and casingheads is taken from the field in the usual type of vacuum gathering system, designed for large volumes and low pipe friction loss. Individual meters are employed to measure gas at each trap, or group of traps, and at each lease in the system for checking loads and for settlement purposes. The main gathering header enters the plant yard from the east side, terminating in a large scrubber installed as a protective measure to remove any material that would cause damage to compressor cylinders. This scrubber is of the centrifugal vacuum type, 8 feet in diameter and 14 feet high, with a shell thickness of 5/16-inch and dished heads ⅜-inch thick. A third head inside of the shell, 4 feet above the base seam, provides a storage space for accumulation of liquid amounting to about 1,600 gallons. The shell of this scrubber is reinforced to withstand full 30 inches Hg. vacuum and it is equipped with a double warning system. The first part of the alarm system is controlled by a float actuating a mercury switch that sounds an alarm when the accumulation space is filled with liquid. If the level continues to rise, a second system operates. This is a float that closes a mercury switch wired to all magnetos in the engine room and its action renders the engines inoperative before damaging materials can enter the compressor cylinders. Adequate connections are provided for emptying the scrubber after the first alarm sounds, with ample time allowed to blow down oil or water before the second mercury switch operates.

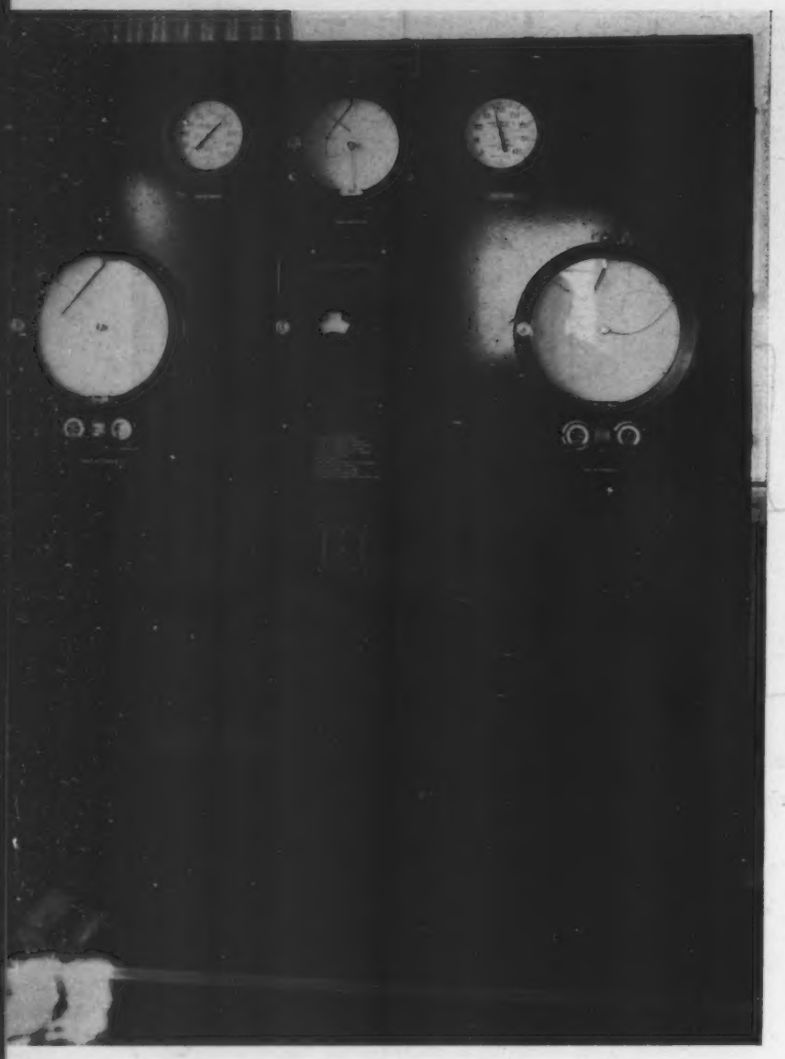
Eight low-pressure cylinders are used at present to handle field gas, holding a vacuum of approximately 7 inches Hg. on the intake header, and boosting this gas to approximately 38/40 pounds gauge, with cooling obtained on the discharge in the usual manner before high-pressure cylinders take their charge. Nine high-pressure cylinders are employed to raise pressure on the gas in this phase of processing, obtaining their intake with a slight pressure drop between that and the low-pressure discharge amounting to about 3 pounds, usually.

The low-pressure gas is scrubbed after cooling in a vessel 4 feet by 10 feet, with the shell and heads made of ¼-inch steel and designed for a working pressure of 75 pounds per square inch. The scrubber is equipped with a mist extractor to prevent the passage of entrained oil and other liquids. Very little condensation is obtained with the first stage of compression, but provisions are incorporated in the inter-stage accumulator for draining liquids and it contains a high-level alarm operated by a float.

High-pressure gas is cooled in a manner similar to the low-pressure system. It enters an accumulator where separation of liquids and gas occur. This accumulator is a vessel 4 feet by 8 feet with a shell thickness of ¾-inch, equipped with ellipsoidal heads ⅝-inch thick, designed for a working pressure of 350 pounds per square inch. The tank is equipped with an internal float which controls discharge of condensate direct to the stabilizer, the gas and mist traveling to the absorber.

THE ABSORBER

The absorber is a vessel 54 inches in diameter by 45 feet in height with a wall thickness of ⅞-inch, ellipsoidal

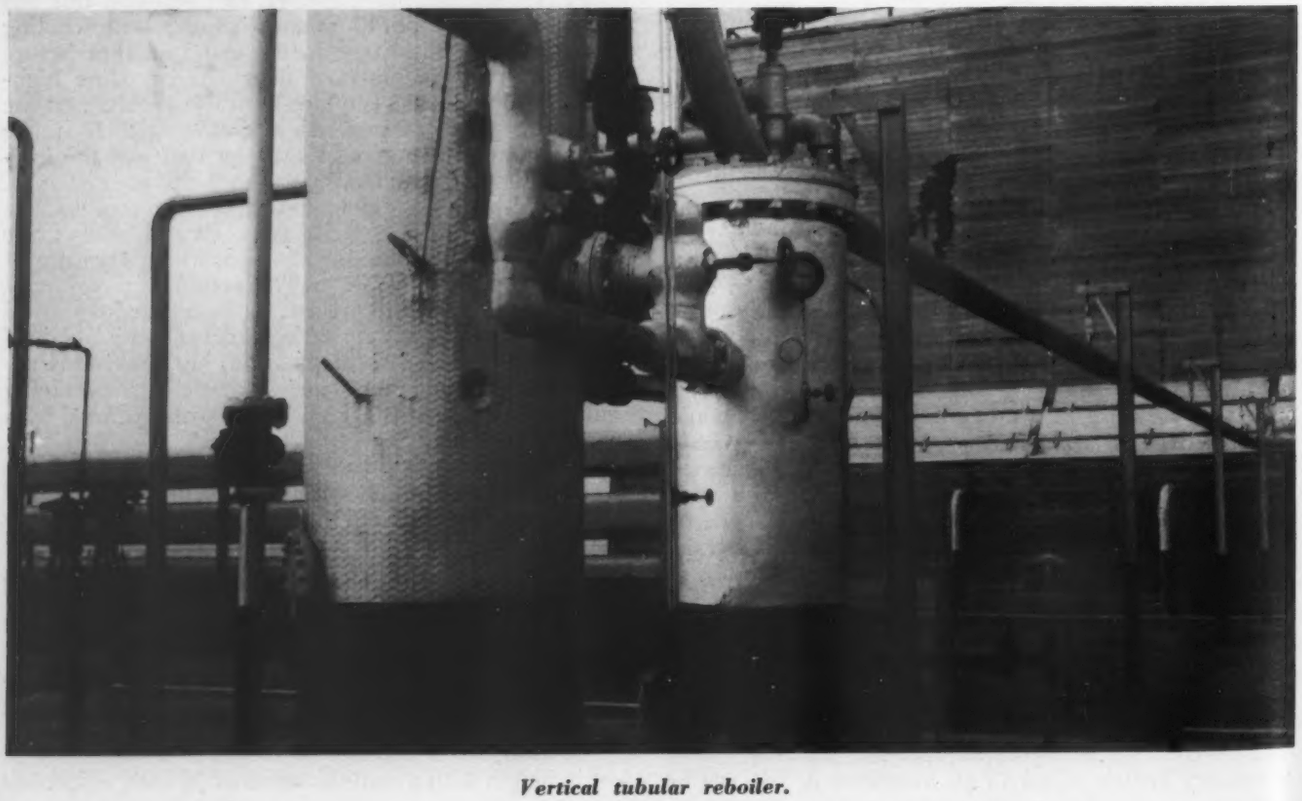


heads 11/16-inch thick, designed for a working pressure of 350 pounds per square inch. The vessel contains 20 absorbing plates with removable hatches affording access to all parts of the interior for inspection and repair. The gas enters the base of the absorber in conventional manner through a series 30 nozzle and is scrubbed of all absorption oil mist by a scrubber built integral with the vessel at its top. Clean gas is thus provided for fuel in various parts of the plant, employes residences and in the field for drilling and operating wells.

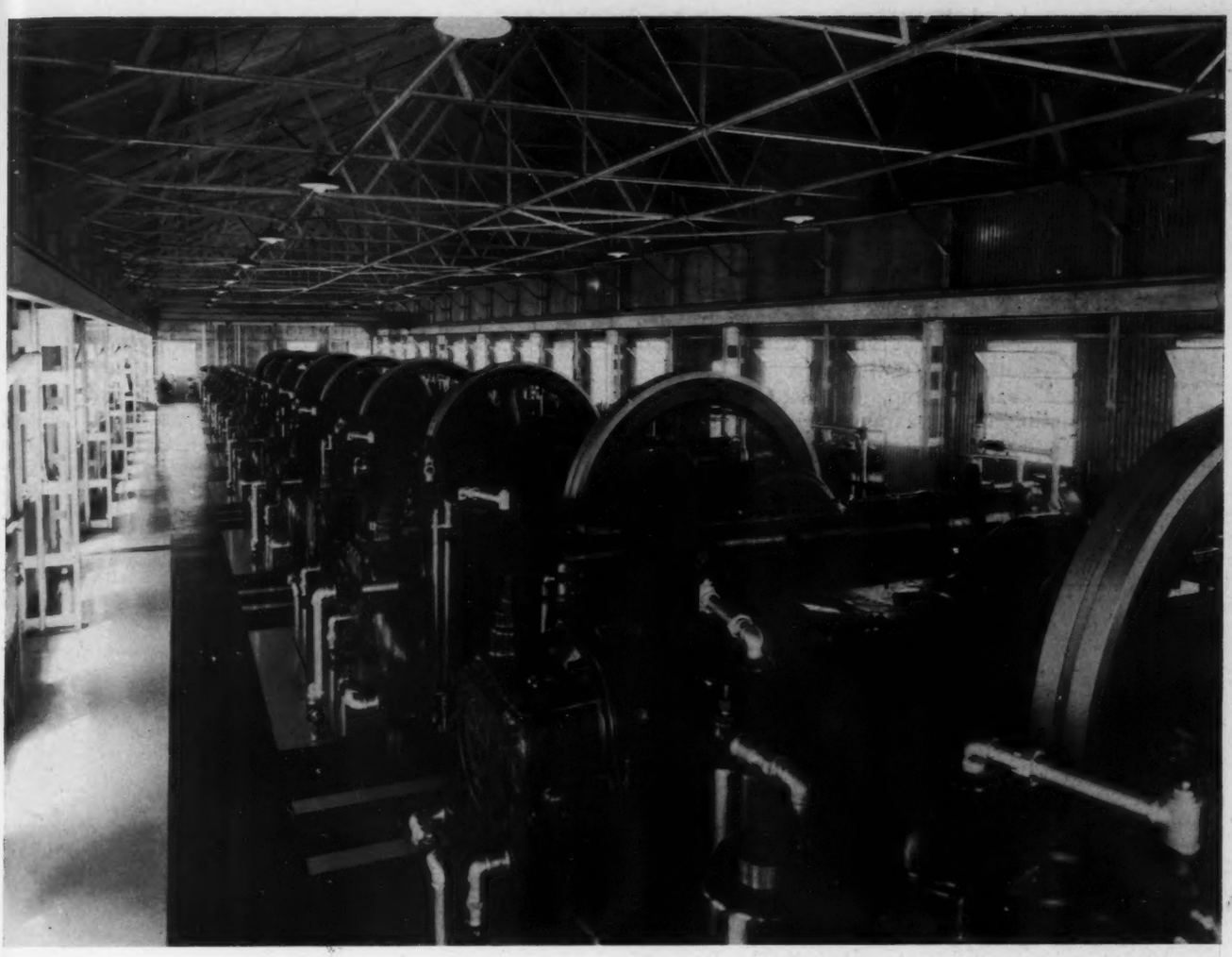
Lean oil from the heat exchangers is delivered to the oil coolers and thence to the absorber by a 10 x 4½ x 12-inch duplex direct-acting, pot-valve type, oil fitted pump rated at 88 gallons per minute at 60 feet per minute piston speed, pumping from atmospheric pressure to a discharge of 350 pounds gauge. Obviously, the amount of absorption oil circulated per hour varies as to the amount of gas being processed and this amount may change frequently during the day because of flowing practices in the field, but the ratio of oil to gas is held at approximately 8 gallons per 1000 cubic feet. The lean-oil suction temperature at the pump averages about 140°F., but the oil entering the absorber is at approximately 10° above wet-bulb temperature. The lean oil enters the shell above the top plate and below the previously-mentioned gas outlet scrubber.

Oil which has absorbed all the desired fractions in the gas is released from the base of the column by an internal float with a balanced valve through a series 30 outlet nozzle. The balanced valve operates both as a fluid controller and a pressure reducing unit, allowing

Simplified instrument panel. Top, left to right: Lean oil pressure gauge; gasoline shipping pump recorder; steam pressure gauge. Center: Stabilizer base temperature recorder-controller; potentiometer dial; still top temperature recorder-controller. Lower center: 12-point knob switch controlling potentiometer.



Vertical tubular reboiler.



Interior view of compressor house, Continental Oil Company gasoline plant at Billings, Oklahoma.

the fat oil to flow to a high-pressure vent tank at a pressure of about 150 pounds gauge. This tank is a vessel 36 inches O.D. and 10 feet net shell height with ⅞-inch walls and ⅜-inch ellipsoidal heads. It contains a mist-extraction unit in the top to prevent escape of entrained fat oil. Vapors released from the oil under the reduced pressure in the high-pressure vent tank are removed under a pressure-controlled outlet connection to plant fuel lines leading to the boiler battery, the vapors containing no appreciable amount of natural gasoline fractions.

Fat oil is released under control from the base of the high-pressure vent tank by an oil-level float control to 2 heat exchangers having a total exchange surface of 680 square feet. As the oil is heated in the exchanger with the lean oil from the still, some vapors are released in solution. Vapors and fat oil are separated in an intermediate vent tank, 2 feet O.D. by 6 feet net shell height. This vessel has ¼-inch shell heads and is designed for a working pressure of 225 pounds, gauge, and it is equipped with a float controller for releasing flashed vapors to recompressor engine suction.

After the fat oil is separated from flashed vapors by the tank between the two sections of exchangers, it passes through a second separating vessel, called the hot-oil flash vent. This unit is constructed of 3 feet of 12-inch pipe, mounted on the exchanger fat-oil outlet, equipped with an internal float for venting flashed vapors into the still. This avoids passing them through the preheater, thus improving the preheater performance appreciably.

Flowing from the fat-oil flash vent, the oil enters the preheater which has a surface of 340 square feet, and is designed for 200 pounds gauge steam working pressure. Here the temperature of the oil is raised to about 382°F. This oil enters the fractionating still above the stripping plates, at which point the vapors from the hot fat-oil flash vent also enter. The still has a shell diameter of 54 inches O.D. and a height of 51 feet, 6 inches, constructed of ¼-inch stock with 5/16-inch code dished heads. It is designed for a working pressure of 85 pounds gauge and contains 8 fractionating bubble cap plates above 10 stripping plates. Two chimney plates are provided, one for fat-oil feed and one for dewatering. Eight feet of open shell space is provided in the base for lean-oil surge, eliminating need for an outside vessel for surplus circulating oil.

THE STILL

The still is operated at a pressure of 40 pounds, gauge, and carries a bottom temperature of 355°F. The fat oil is stripped in the base by superheated steam. The top plate temperature is controlled at about 185°F. by pumping reflux over the top fractionating plate with a 1½-inch centrifugal pump rated at 35 gallons per minute with a suction pressure of 30 pounds gauge and a discharge pressure of 65 pounds gauge. The operating speed of this pump is 1800 r.p.m. and it is driven by a steam turbine that handles a gang setting including

three water pumps and the still reflux pump. Stripped absorption oil, leaving the base of the still, is under sufficient pressure to pass it through two units of exchangers and to the suction of the main circulating pump to complete the cycle.

Condensed gasoline enters the dewatering tank, a vertical vessel 96 inches O.D. by 10 feet net shell height. This vessel is constructed of ¼-inch material with 5/16-inch code dished heads for an operating pressure of 50 pounds per square inch. It is mounted on an elevated skirt 48 inches high and is equipped with a column of gauge glasses and an interface level control at the bottom for draining water. Fractionating still reflux is taken from this vessel, with production flowing to the stabilizer charge pump.

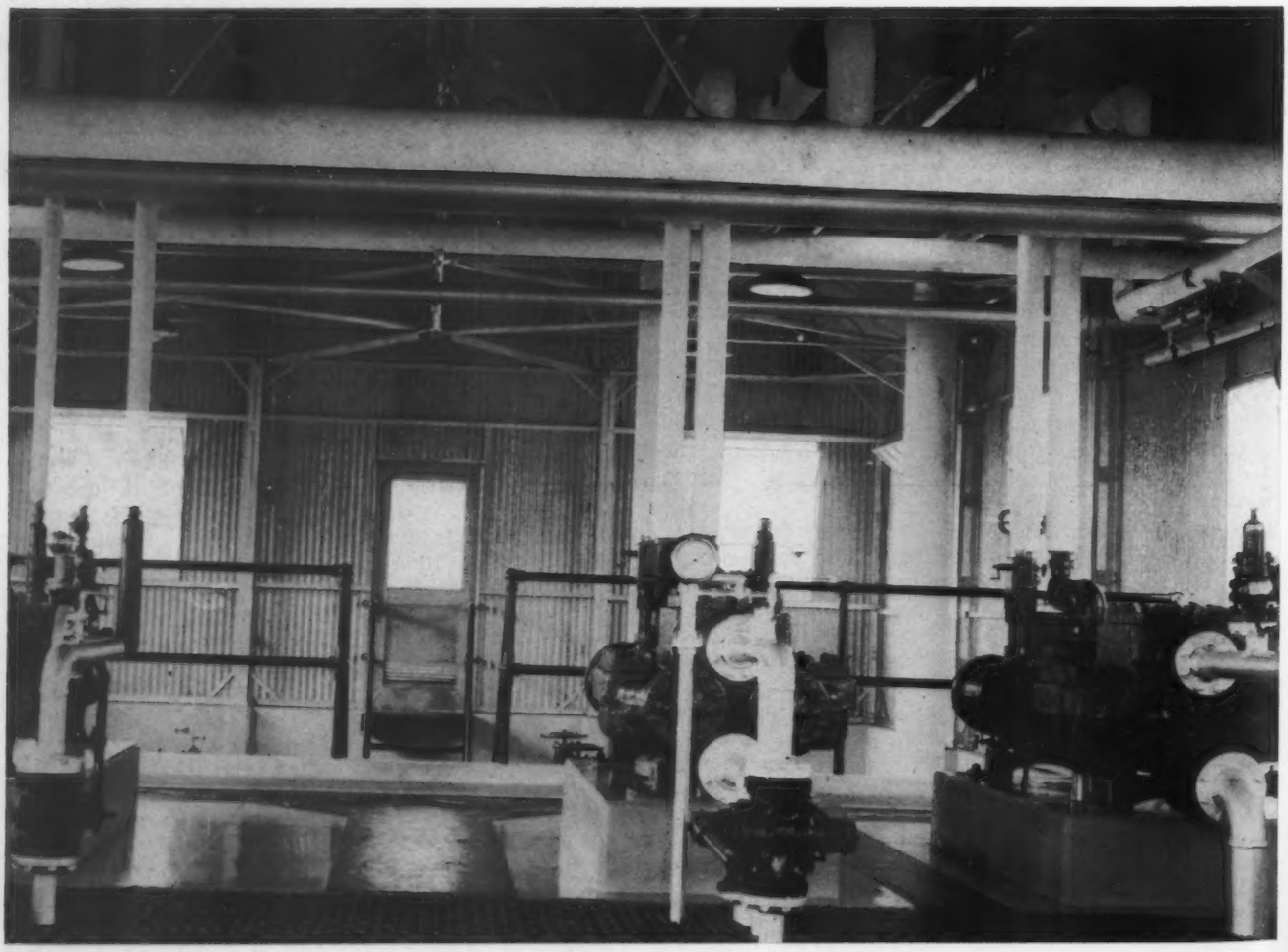
The stabilizer charge pump, size 8 x 6 x 12-inch, a duplex direct acting, close clearance type, is rated at 60 gallons per minute when operating with a suction pressure of 30 pounds and a discharge of 275 pounds with steam at 200 pounds gauge pressure. It handles all the absorption gasoline; the compression gasoline joining the stabilizer feed line at the inlet of the gasoline exchangers. These exchangers are of standard manufacture, four in number with a total exchange surface of 411 square feet, stacked in a steel supporting frame on a concrete foundation beside the stabilizer.

THE STABILIZER

The stabilizer is a 30-plate tower, 36 inches O.D. by 56 feet net shell height, with 7/16-inch walls, ⅜-inch ellipsoidal heads and designed for a working pressure of 250 pounds gauge. The stabilizer reboiler is a vertical tube shell 5/16-inch thick, 20 inches I.D. by 66 inches high. It is designed for a working pressure of 250 pounds and contains 157 square feet of heating surface in the form of ¾-inch O.D. by 18 gauge admiralty bronze tubes, provided with removable heads for access to the tubes. Steam dried of moisture by efficient traps is admitted to the shell of the reboiler under instrument control which maintains any desired temperature. The operating conditions at this time call for a reboiling temperature of 292°F. when manufacturing a 22-pound Reid gasoline.

The stabilizer contains 30 fractionating bubble trays, the feed being admitted at the middle of the column between the 15th and 16th trays. The overhead is condensed as required for reflux when there is no demand for stabilizer overhead discard liquid, allowing surplus vapors to pass into fuel or disposal lines while hot. The stabilizer may be operated over a wide range, obtaining high-vapor-pressure gasoline, or the product may be fractionated down to a butane-free material at will.

Gasoline leaving the base of the stabilizer passes back through the exchangers under controlled pressure, and it is treated with solidified cupric chloride to sweeten. Five storage tanks are located at the west end of the plant yard from which treated gasoline is pumped by a duplex direct-acting, close-clearance unit, 10 x 3½ x 12-inch, rated at 35 gallons per minute pumping from 10 pounds suction to 1000 pounds discharge.



Interior of the pump room.

The cooling tower is totally enclosed.

COOLING TOWER

Cooling of plant circulating and jacket water, as well as gasoline, gas and absorption oil is obtained in an induced down-draft cooling tower. This structure is 132 feet long, 22 feet wide and 36 feet high. It is constructed of California redwood, internally guyed and braced with galvanized steel hardware to withstand a wind velocity of at least 90 miles per hour without the necessity of external guying. The tower is mounted in a shallow reinforced-concrete basin 132 feet long and 39 feet wide with 2-foot square concrete bearing-blocks under each main post; the posts being secured by galvanized steel clips cast in the concrete.

The tower is divided transversely across the middle into two sections, i.e., a "hot" section or end and a "cold" section or end. Each section is provided with a separate water-circulating system. All commodity streams are first cooled in the "hot" end after which they are passed through the "cold." Cooling in the hot end is accomplished largely by evaporation off the cooling surfaces due to the high temperature gradient, while in the cold end the heat is dissipated more through sensible heat rise since the temperature gradient is smaller; this arrangement on the whole allowing a close approach to wet bulb, it is claimed. Typical tower performance is as follows: dry bulb, 79°F.; wet bulb, 70°F.; average of outgoing commodity temperatures, 76°F. Wind loss through drift can be accurately controlled and limited to a low amount when adjustable wind-louvres located along the base of the tower at its sides are properly set to cope with high external wind velocities.

The cooling tower, which is essentially a wind-proof structure except for the previously mentioned louvres, obtains its cooling of water and induced down-draft by high-velocity spray water directed downward from 1-inch centrifugal spray nozzles set in headers at the extreme top of the tower. Spray water is handled by two 8-inch centrifugal pumps set in gangs with the jacket-water pump and still-reflux pump driven by a 100 horsepower steam turbine. Stand-by service is obtained from a duplicate installation. Each pump handling water over either end of the cooling tower is designed for a circulation of 1650 gallons per minute from zero pressure intake to 30 pounds discharge. No connection is provided for water to flow from the hot to the cold end of the tower as each system performs a definite function in reducing the temperatures of gases and liquids passing through the cooling sections.

The total cooling surface in this tower is 9048 square feet, which is served with a total water circulation of 3300 gallons per minute.

Inasmuch as draft through the tower is induced by the velocity of the spray water, ice can be eliminated entirely during winter by limiting the circulation of air through the tower by adjustment of the movable louvres at the base.

Vapors which cannot be condensed to a liquid state, and that are released from the hot fat oil in the intermediate vent tank, and from the gasoline dewatering tank are recompressed in a cylinder on one of the main compression units. These are delivered to the stabilizer feed line without cooling for hot fractionating along with the liquid charge. A fluid stop tank, or scrubber, is installed on the suction line to the recompressor cylinder. This tank is equipped with a drain connection and a

float-operated mercury switch which shorts out the engine ignition if liquid rises in the tank to a dangerous level, thus "killing" the engine before damage can be done by liquid entering the compressor cylinder.

Another feature of the plant is the slop classifier. This is a housed 3-compartment steel tank 3 feet wide by 4 feet high and 10 feet long. It is installed to separate water from plant drainings, salvaging oils and gasoline and disposing of water automatically to the sewer without hazard of fire caused by open skimming pits.

PIPING

Piping in the pump rooms and other points where access is required is carried in concrete-lined trenches. The lines are spaced at sufficient distances from each other so that repairs and maintenance are facilitated. These trenches are all covered with steel grating, removable in sections and also are provided with adequate drain lines so that dirt can be flushed out as often as necessary.

ENGINE OIL FILTER

The method of filtering oil used to lubricate the compressor units constitutes a newly developed feature introduced in this plant. Departing from general practice which requires each compressor unit to be equipped with individual filters and oil pumps, used oil from all units is pooled and handled in a single filtering and supply system. This comprises two settling basins which are fed through a 4-inch header running the entire length of the engine house in front of the compressor end of the units. A 3-way valve regulates the flow of oil and the stream can be directed into either one of the settling basins as required. Each of these sumps has a capacity of approximately 200 gallons and this allows a portion of the oil to settle in one of the basins while the balance is being used. Water and heavier elements contained in the used oil settle to the bottom of the sump and are removed by periodic cleanings.

The oil is pumped to an overhead reservoir, passing on the way through two filters connected in series, by a small pump operated by low-pressure discharge gas from the compressors. A manually operated stand-by pump is included as a reserve against interruption in the supply of low-pressure gas. The pump suction lines, installed in the basins, are so arranged that they can be adjusted in height. This permits draw-off from near the top of the purged oil level. The oil flows from the reservoir by gravity back to a 4-inch header running the length of the engine house and to the engines, individually, through 1½-inch lines.

Operation of this filtering system is entirely automatic. High- and low-level controllers operate valves controlling the pump. A predetermined low level has been established and when the level of the oil in the sump falls to this point, the low-liquid-level controller sets the pump in operation until the predetermined high-level point is reached and the high-liquid-level controller operates to stop the pump.

A low-level cut-out is provided on the clean oil storage tank to shut down all engines in case the supply of oil in this tank should, for any reason, reach a dangerously low point. Individual oil pressure cut-outs are included to guard against failure of the force-feed oiling units on each engine. High-temperature cut-outs are also installed on the jacket-water outlets to shut down each engine individually in case the water temperature should become excessively high.

The absorption plant is entirely automatic in its operation after the operator has manually set the lean-oil circulation rate. To further the various convenience features of the plant, as well as to simplify the work of the operator, the controls are all concentrated on a panel located inside the pump house.

CONTROL INSTRUMENTS

The outstanding feature of the control panel is the inclusion of a multiple-point indicating potentiometer which enables the operator to obtain temperature readings from 12 different points in the absorption and stabilization cycles by simply turning a knob-switch. This instrument enables the operator to obtain temperature readings, without leaving his seat, at the following points:

Rich oil to still from preheater,
Fat oil out of exchanger to preheater,
Lean oil out of exchanger to cooling tower,
Hot lean oil out of still to exchanger,
Lean oil out of cooling tower to absorber,
Fat oil out of absorber,
Gas into absorber,
Jacket water out of engines to cooling sections,
Water over sections, "hot" end cooling tower,
Water over sections, "cold" end cooling tower,
Stabilizer vapor top temperature,
Raw gasoline out of cooling tower to dewatering tank.

STEAM PLANT

The steam plant consists of three locomotive-type boilers, each rated at 125 horsepower, 250-pound steam working pressure, set for operating at 150 percent of nominal rating and fired by gas. Each boiler is equipped with an automatic water-level controller and automatic burners equipped with draft controllers. Gas is piped to the boiler room under plant pressure where it is reduced through two regulators in series with a scrubber between them. The first reducing instrument lowers the pressure of the gas to a few pounds, while the second automatically feeds low-pressure gas under controlled volume to the burners as steam requirements indicate.

All concrete foundations have a minimum strength of 2500 pounds per square inch at 28 days cure and all floors and engine bases are finished smoothly to take paint finish. Floors are painted and waxed to prevent accumulation of dust and oil and occasional dusting with a large oil mop is all that is required to maintain an exceptionally neat appearance.

The absorption side of the plant is designed to handle 15,000,000 cubic feet of gas daily; sufficient engine capacity is installed to handle 9,000,000 cubic feet at present. Gas repressuring equipment is also to be included in the plant, but this project is not now under way. The plant recovers approximately 2 gallons of natural gasoline per 1000 cubic feet with the final product having a Reid vapor pressure of 26 pounds. A typical analysis of the composite gas is, as follows:

	Percent
Methane	59.04
Ethane	14.81
Propane	14.60
Butane	8.21
Pentane	2.33
Hexane plus	1.01
Total	100.00

Analysis of the gasoline shows the following:

	Percent
Propane	0.00
Iso-Butane	0.13
Normal Butane	19.97
Pentane	50.03
Hexane plus	29.87
Total	100.00

Transportation and Utilization of

Light Hydrocarbons

From East Texas

S. D. TURNER* and A. C. RUBEY
Humble Oil & Refining Company,
Baytown, Texas

Paper presented before the White Sulphur Springs Meeting of the American Institute of Chemical Engineers

BUTANE has long been the key hydrocarbon in the control of gasoline volatility and the operation of light hydrocarbon recovery equipment, in that, while its recovery for inclusion in gasoline has been economically desirable, its inclusion has been limited by maximum allowable gasoline vapor pressure. Consequently, while in the past most of the butane recoverable in the petroleum refining industry has been utilized, some has been burned as fuel, with an appreciably lower return to the refiner, or wasted altogether. Recent increases in the recovery of natural gasoline in the producing fields and, of more importance, in the production of cracked gasoline, which has approximately doubled in the last six years, have so increased the quantities of butane recoverable that the amounts that cannot be utilized in motor fuel, and hence be burned as fuel or wasted, have increased enormously. Concurrently, much progress has been made in the field of the conversion of hydrocarbon gases by polymerization processes into liquid hydrocarbons that are usable in gasoline because of their relatively low volatility. In general, the development of these processes has been such that polymerization of the heavier gases seems more economically attractive than of the lighter ones. For this reason, commercial developments for such conversion of butanes and propanes, the latter not being usable at all in gasoline, have been rapid. This paper describes the developments in this field recently completed by Humble Oil & Refining Company in East Texas and at its Baytown refinery for the conservation and utilization of such light hydrocarbons. It is believed that an account of these developments is worthwhile in that several units in the project are unique, and in that all steps of the development have been made on an unprecedented scale.

The principal elements of this development are shown schematically in Figure I. The numerical values shown on this diagram must be regarded as approximate averages, and have been included only to give some idea of the scale of operations. Variations due to seasonal trends and other factors result in quantities during certain periods quite different from those shown. A supply of about 9500 barrels daily of butanes was developed in East Texas by expansion of the company's own recovery facilities, and by purchase from others. These butanes, with varying amounts of propane, are blended with natural gasoline to reduce vapor pressures to a maximum of about 60 pounds vapor pressure (Reid method) at 100° F., and the mixture is brought to Baytown by pipe line. A portion of the butane is used as charge to a thermal polymerization plant, while the remainder is used to blend gasoline shipments to maximum allowable vapor pressures, thereby releasing plant recovered butanes, formerly used for this purpose, for charge, along with the first-mentioned portion of the field butanes, to the thermal polymerization plant. The butanes recovered from refinery operations are passed through a sulphuric acid polymerization plant, where co-dimer (an iso-octene formed by the union of one molecule of iso-butene and one of n-butene) is formed, before charging to the thermal polymerization plant, since a higher return is effected by conversion of the unsaturates to co-dimer than by charging them to the thermal polymerization plant. This co-dimer plant, however, is somewhat independent of the main project under discussion. Even in this brief description of the operations as a whole, attention should be called to the superfractionation employed to separate field butane isomers, allowing isobutane to be used principally as charge to the thermal polymerization plant and normal butane to be used in gasoline blends, and to separate isopentane from the debutanized field casinghead. In addition to the pipe line and processing units, pressure storage for the volatile products had to be provided both between processing operations and before shipment. The design and operation of each of these is discussed in some detail below.

The 8-inch pipe line, approximately 300 miles long, to carry a mixture of natural gasoline and excess butanes and propane having a Reid vapor pressure between 40 and 60 pounds from a gathering station near New London, Texas, to Baytown, was put into operation in July, 1936, by Humble Pipe Line Company. A considerable portion of the line was provided by converting an existing crude pipe line into this service. As originally installed, the only pump station was at New London, and a capacity of about 11,000 barrels daily was obtained with 700 pounds discharge pressure. Two 8-stage centrifugal pumps, connected through speed increasers to 300 horsepower gas engines, were employed, one of these being a spare. Subsequently, a booster station was

* Present address: Standard Oil Company of New Jersey, New York, New York.

put into operation at Hearne, midway between New London and Baytown, increasing the capacity of the line to approximately 15,000 barrels daily. Additional temporary booster stations were later installed at points midway between New London and Hearne and between Hearne and Baytown, increasing the line capacity to about 19,000 barrels daily. Additional natural gasoline from Humble Oil & Refining Company plants in the Conroe and Tomball fields is introduced into the main line at Satsuma, the location of the last booster station.

At both New London and Baytown, the entire stream is metered through displacement meters. Means are provided at each point for careful and frequent calibration of the meters, and in these calibrations it is usual for a meter accuracy of 0.1 percent to be obtained. Continuous vapor-pressure recorders have been installed and are in operation at both the New London and Baytown ends of the line.

An unusual feature of this system is that no storage is provided along this line between New London and Baytown, each of the booster stations operating without the benefit of storage or surge tanks.

SUPERFRACTIONATION PLANT

The equipment for rectification of the pipe line propane-butane-casinghead stream was put into operation in the spring of 1937. A view of the columns is shown in Figure 2.

In the first column, propane and lighter fractions are removed, with provision for taking a highly purified propane side stream from near the top for sale as bottled gas or for use at a propane lube-treating plant. In the second column, the total butane cut is taken overhead. A portion of the bottoms from this tower is charged to a third tower for removal of isopentane. In the fourth tower the butanes taken overhead from the second tower are divided into iso and normal fractions. The plant also includes two other towers which are used in similar operations on plant-recovered light ends.

Principal data on the fractionating towers mentioned are tabulated as follows:

	Column I Depropanizer	Column II Debutanizer	Column III *Iso*-pentane Tower	Column IV Butane Fractionator
Diameter, feet	8	10.5	7.0	8.5
Height, feet	111	103	120	111
No. of Trays	45	40	50	45
Safe Working Pressure	275	100	50	120
Reflux/Overhead (design)	12.8	2.6	15.5	10.3

A typical composition of the feed stock is as follows:

	Liquid Volume Percent
Propane and Lighter	8.8
*Iso*butane	11.9
n-butane	42.0
*Iso*pentane	11.3
n-pentane	10.6
Heavier	15.4
	100.0

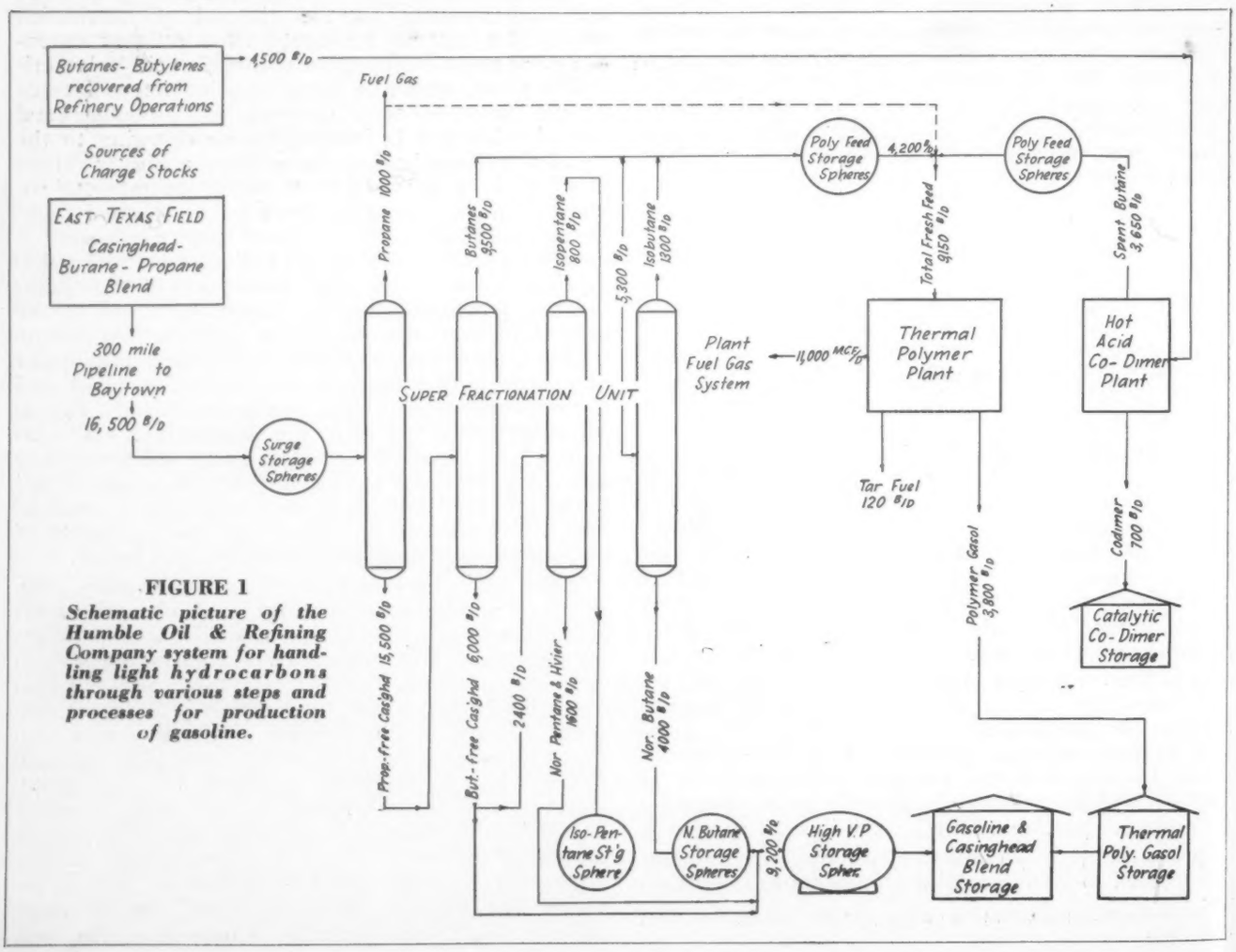


FIGURE 1

Schematic picture of the Humble Oil & Refining Company system for handling light hydrocarbons through various steps and processes for production of gasoline.

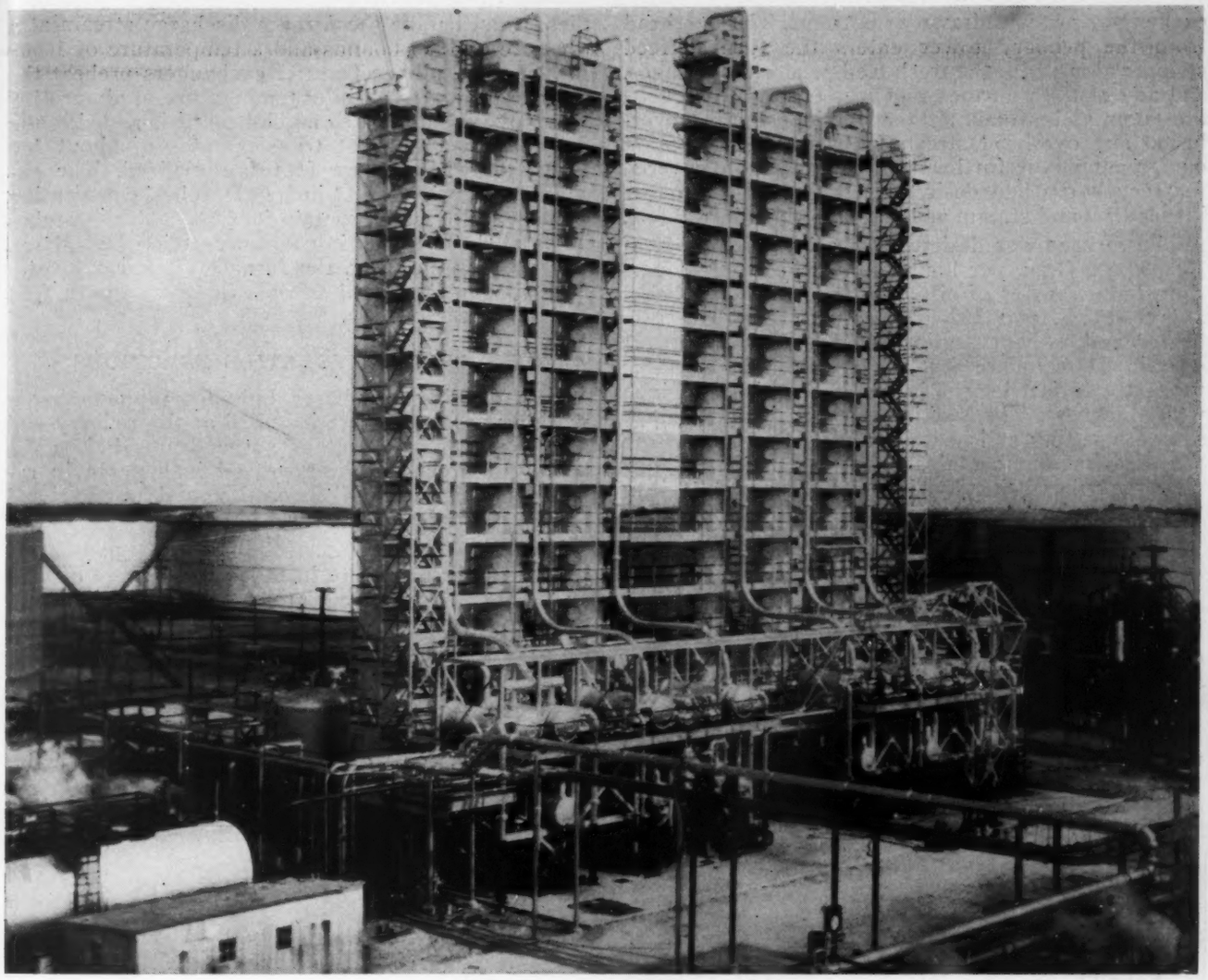


FIGURE 2

Rectification system for superfractionation of the pipe line propane-butane-casinghead gasoline stream. Humble Oil & Refining Company, Baytown, Texas.

The outstanding feature of this equipment is the high purity of products obtained on an operation of such a large scale. Analyses of products obtained during a test run are shown in Table 1.

THERMAL POLYMERIZATION PLANT

In this plant, the so-called Unitary process is employed, the light hydrocarbons being cracked and polymerized simultaneously in a coil at a temperature of about 1025° F. and a pressure of about 1800 pounds at the heater outlet. Figure 3 shows a general view of the plant.

The equipment was designed to charge 6700 barrels daily of fresh feed with a total feed of 27,600 barrels daily through the coil, producing 3260 barrels daily of polymer gasoline. However, fresh feed rates up to 10,000 barrels daily, with a production of 3500 barrels daily of polymer gasoline, have been realized by discarding to residue gas a portion of the propane produced in the reaction, which the design contemplated recycling. The recycling of maximum quantities of propane or the inclusion of propane in the fresh feed is economical only when there is insufficient butane to run the plant at full capacity. Furnace charge rates of 38,000 barrels daily have been realized. A conversion of 16.7 percent by weight (to total liquid product of 10 pounds R.V.P.) was contemplated in the design, and this is being met very closely in current (March 1938) operations.

TABLE 1
Superfractionation Unit—Product Analyses

Tower	Charge B/D	Impurities in Overhead	Impurities in Bottoms
1	10,450	0.96% C_4	0.0% C_3
2	10,160	3.4% C_5; 0.0% C_3	0.0% C_4
3	2,266	0.0% nC_5; 0.0% C_4	0.2% iC_5
4	2,900	0.7% nC_4; 0.0% C_3	0.3% iC_4; 0.4% C_5

Principal features of the unit are shown in the flow diagram, Figure 4. The coil discharge stream, after being cooled in transfer line exchangers and a water cooler, enters a primary tower operating at 400 pounds, where butane and lighter fractions are taken overhead and polymer gasoline is withdrawn as bottoms. This latter stream enters the gasoline tower, operating at atmospheric pressure, where light polymer gasoline is taken overhead, heavy polymer gasoline is withdrawn as a sidestream, and heavy polymers and cycle stock for quenching the transfer line

exchangers are withdrawn as bottoms. The overhead from the primary tower enters the furnace feed stripper along with the fresh feed, where the butanes, and any of the propanes that it is desired to recycle, are taken as bottoms, lighter fractions coming overhead. The overhead stream passes to refrigeration equipment where further propane may be recovered for recycling when desired. Representative product inspections and stream analyses are given in Table 2.

The furnace was designed for a heat liberation of 132,000,000 B.t.u. per hour and efficiency of 61 percent, temperatures of oil entering and leaving being about 615° F. and 1025° F., respectively. The preheater and radiant sections in the furnace proper contain 7140 square feet of outside tube surface; tubes are 40 feet long, 5 inches O.D., with a ¾-inch wall thickness. The soaking section, which is in a separate setting and heated only by flue gases from the fired furnace, contains 13,448 square feet of surface, the tubes being 5½ inches O.D. and 9/16 inch thick. All tubes, other than those in the first part of the preheater, are of a 2 percent chromium and ½ percent molybdenum composition. The total feed is pumped through the furnace by two single-stage double-acting quintuplex pumps, operating in parallel, each driven by a single-tandem, horizontal four-cycle, double-acting gas engine with a 25-inch bore and 36-inch stroke, rated at 825 horsepower at 138 revolutions per minute.

The transfer line exchangers are thought to be an unusual feature of the equipment. The first set of these must handle the furnace discharge stream at a pressure of 1900 pounds and a temperature of 1000° F. Together, all the transfer exchangers preheat the furnace charge to an inlet temperature of about 615° F., recovering almost as much heat as is added in the furnace. Average heat transfer rates of about 180 B.t.u./hour/° F./square foot are realized. The exchangers consist of 8.15-inch O.D. tubes, constituting shells, each of which contain four 2⅜-inch O.D. tubes in parallel. The flow is counter-current throughout. To facilitate cleaning, the furnace discharge stream flows inside the small tubes with the furnace feed stream on the outside.

STORAGE OF VOLATILE FRACTIONS

Two 2500-barrel spheres, built for 100-pound safe working pressure, were installed at the refinery end of the pipe line to act as surge drums before the rectification plant. These proved inadequate in capacity to insure smooth operation, and an additional 5000-barrel sphere has been added.

Three 12,500-barrel spheres, built for 50-pound safe working pressure, were installed for storage of field and refinery butanes cut at the rectification plant to be fed to the thermal polymerization plant or blended into finished gasolines. Because of an increase in the volume of materials to be handled, this storage has been increased to five spheres, providing a total capacity of 62,500 barrels.

Since the refinery acts as a terminal for the 18-

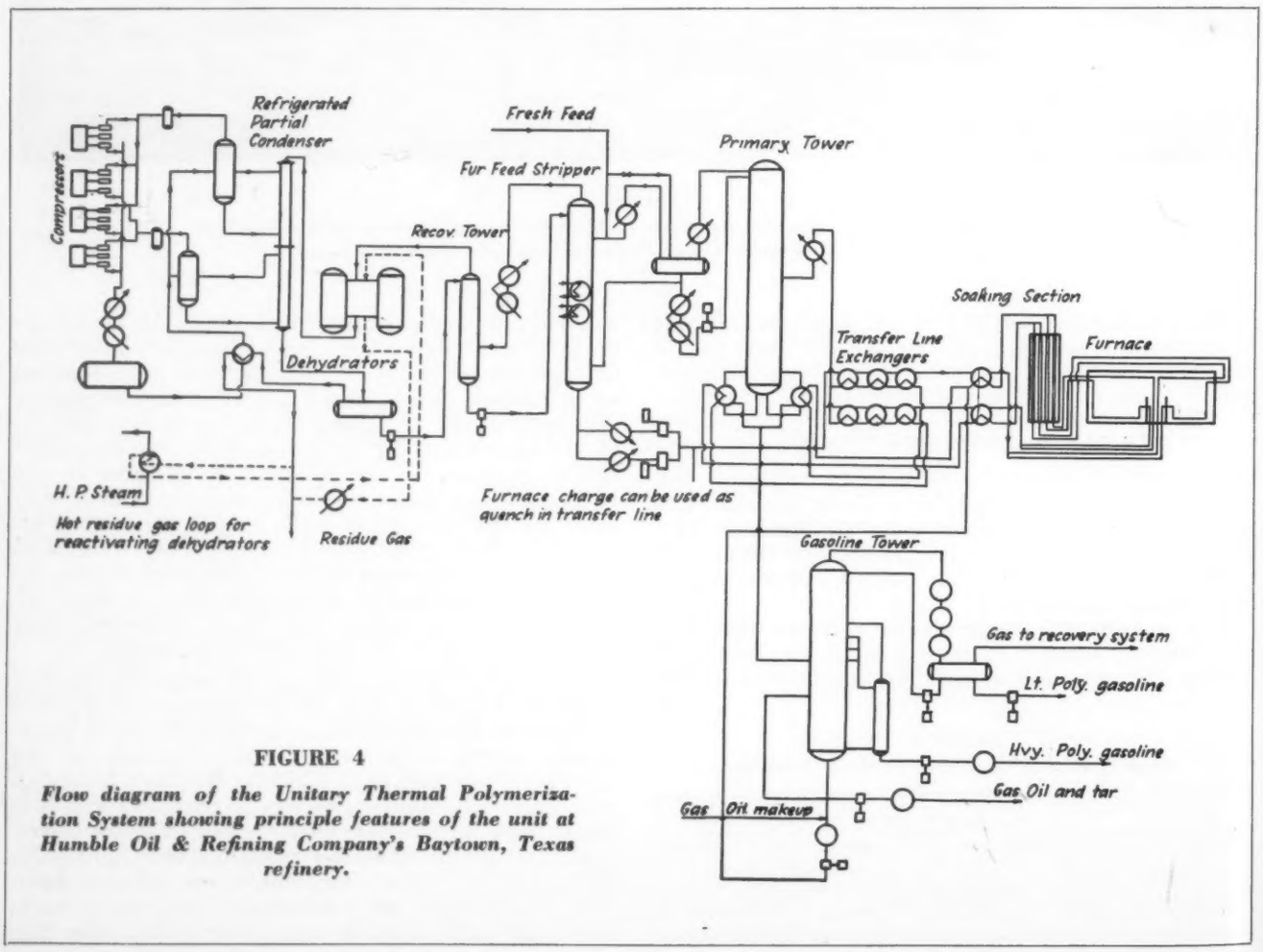


FIGURE 4

Flow diagram of the Unitary Thermal Polymerization System showing principle features of the unit at Humble Oil & Refining Company's Baytown, Texas refinery.

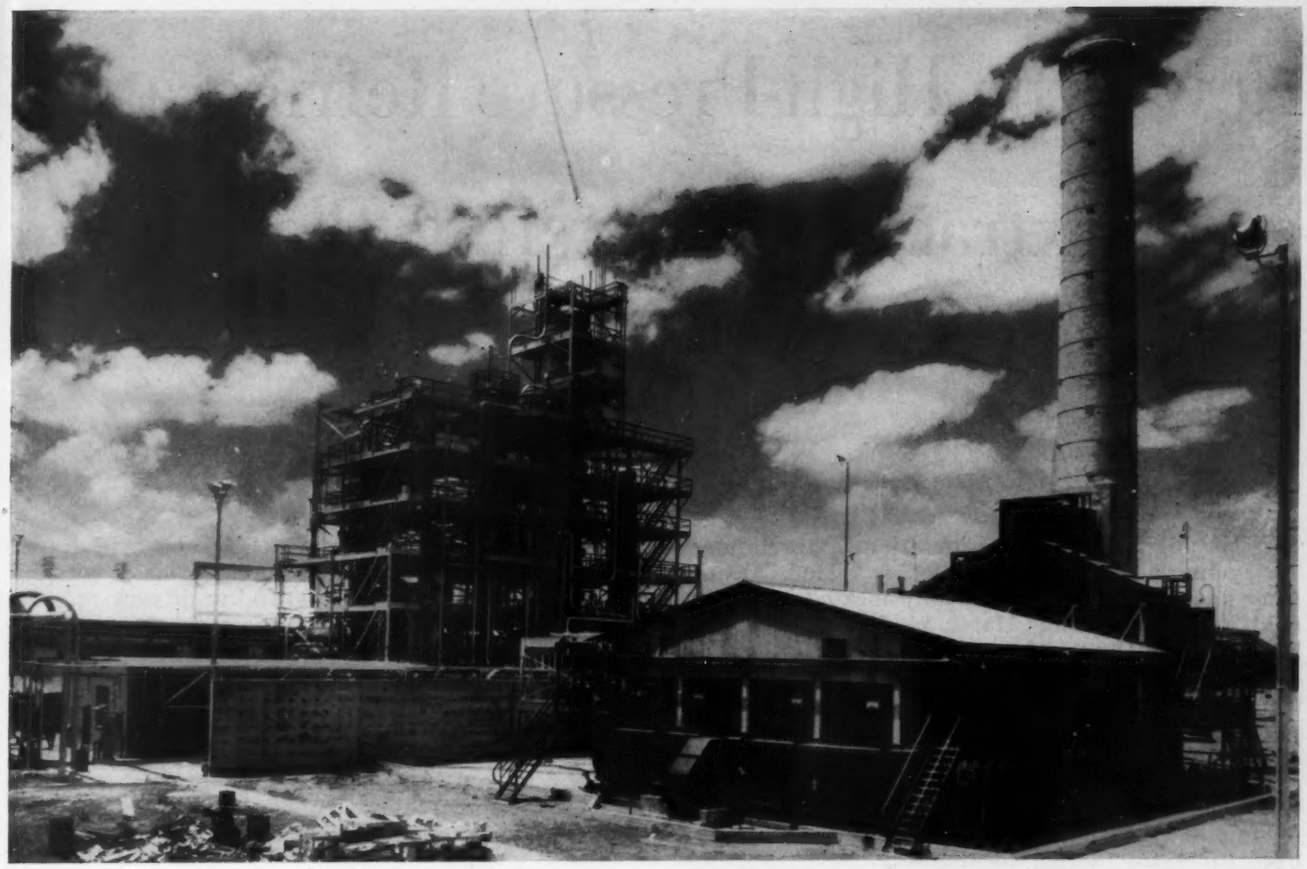


FIGURE 3

General layout of the Unitary Thermal Polymerization Plant at Humble Oil & Refining Company's Baytown, Texas refinery.

pound natural gasoline brought through the pipe line with the excess butane and propane from the East Texas field, considerable storage is necessary for this material. Three 80,000-barrel spheroid tanks, two good for 15 pounds, the third for 10 pounds gauge safe working pressure, have been installed. The refinery already had in service two 80,000-barrel insulated and refrigerated tanks for casinghead storage, so that storage is available for 400,000 barrels of casinghead of Reid vapor pressure up to about 32 pounds. The insulated and refrigerated storage was installed a number of years ago in preference to pressure storage primarily because spare tankage was then available, which allowed the casinghead storage to be provided at only the cost of insulation and the installation of vapor recovery facilities. Current operations indicate that the above storage is inadequate, and construction of two additional 80,000-barrel spheroids is planned, bringing the total storage available for 32-pound products up to 560,000 barrels.

TABLE 2

Thermal Polymerization Unit: Typical Product Inspections and Stream Analyses

	Light Polymer Gasoline	Heavy Polymer Gasoline	Gas Oil and Tar
Gravity, ° API	75	44	20
I. B. P., °F	90	195	370
F. B. P., °F	245	450	90% @ 660°F.
Percent @ 158 °F	58	....	.....
Percent @ 212 °F	95	2-3	.....
R. V. P., Lbs./Sq. In.	13	2-3	.....
O. N., C. F. R. (Clear)	77.5	75.0	.....
O. N., C.F.R. (Blending Value*)	87.0	....	.....

*When blended to a 30% mixture with 65 O. N. reference fuel.

Mol. Percent	Fresh Feed	Furnace Feed	Residue Gas
C_1	.....	.....	51.0
C_2	.....	1.5	28.0
C_3	.....	10.5	19.5
i-C_4	20.0	30.0	1.5
n-C_4	80.0	58.0	
Total	100.0	100.0	100.0
Unsaturates	15.0	14.0	12.0

FORCED-DRAFT COOLING TOWER

Cooling water for both the thermal polymerization and superfractionation plants is provided by a forced-draft cooling tower. The tower is 237 feet long, 56 feet wide, and 36 feet high, and is divided into 28 cells, each equipped with a 20 horsepower, 1750 R.P.M. electric motor, geared to drive a fan at a speed of 350 R.P.M. There are approximately 1500 spray nozzles in the installation. With all cells in operation, the tower is designed to cool 21,000 gallons per minute of water from 120°F. to 85°F., at a wet bulb temperature of 80°F. The circulating system is of the closed type; the water is pumped from the pit of the tower through the equipment and back over the tower with one set of pumps. Pumping equipment consists of four units: two motor-driven, one steam-driven, and one dual-drive, each rated at 7500 gallons per minute against a 180-foot head.

New Type High-Pressure Refrigeration Extraction Recycling Plant at Cayuga

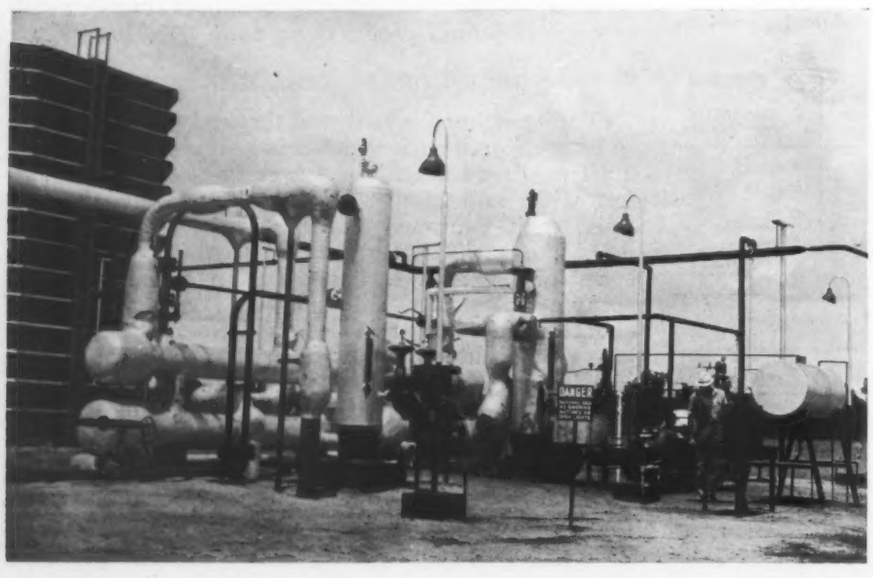
THE high-pressure refrigeration extraction recycling plant of Tide Water Associated Oil Company and Seaboard Oil Company located in Cayuga field, started operating March 24, 1938. The plant is located on a 10-acre tract of fee land on the J. A. Campbell lease in the James Wilson Survey, Anderson County, Texas.

The plant is the first of the type to be built and was installed by Tide Water Associated-Seaboard for experimental and determination purposes, all which have not as yet been completed. Letters of patents are pending in connection with the process used for extraction of the natural condensate from the gas under high pressures. The process includes refrigeration resulting from expansion of the gas and alo employs the use of ammonia or other refrigerating mediums to aid in obtaining the definite temperatures desired. The system employs the use of heat exchangers and other equipment and methods of handling the gas to obtain high efficiency of reaching sub-normal temperatures with a minimum horsepower requirement.

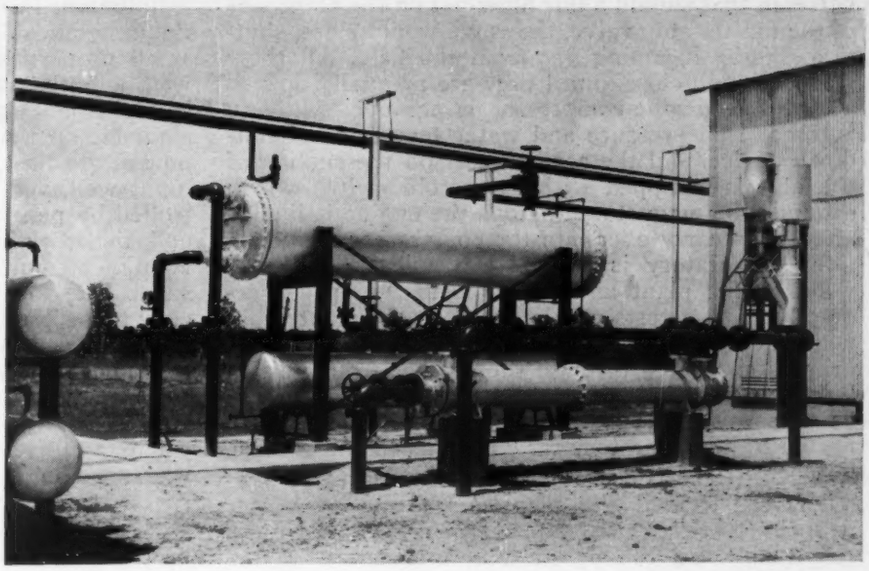
The gas is withdrawn from wells completed in the Woodbine sand and returned to input wells completed in the same formation. The extraction of condensate is made under high pressures in order to reduce the horsepower required to return the gas to the same formation from which it was withdrawn. Very little was known about the behavior of complex mixtures at higher pressures, and until very recently no method of calculation of the mechanics of condensation was considered available. This plant was designed from the actual results obtained from the operation of a small test plant. The designer was inspired to make these tests by observing the performance of gas from the deeper horizon and to create a revenue for operators holding vast gas acreage when market for gas is not available, particularly gas containing an appreciable distillate content.

The equipment throughout the plant is of the most modern design and the plant is laid out and constructed in a manner to afford the greatest degree of efficiency, safety and flexibility for the addition of other units. The engine-compressor is 400 horsepower, with vertical power cylinder and horizontal compressor cylinders. The ammonia and gas cylinders are attached to the same machine.

All high-pressure vessels are stress relieved and X-rayed. Some were constructed of a special alloy steel. Most of the high-pressure piping was shop fabricated, and all high-pressure joints and fittings are of ring gasket type. The water pumps are steam driven, some being of the centrifugal and others of



The cooling tower, heat exchangers, high-pressure traps and chemical pumps are shown in this view.



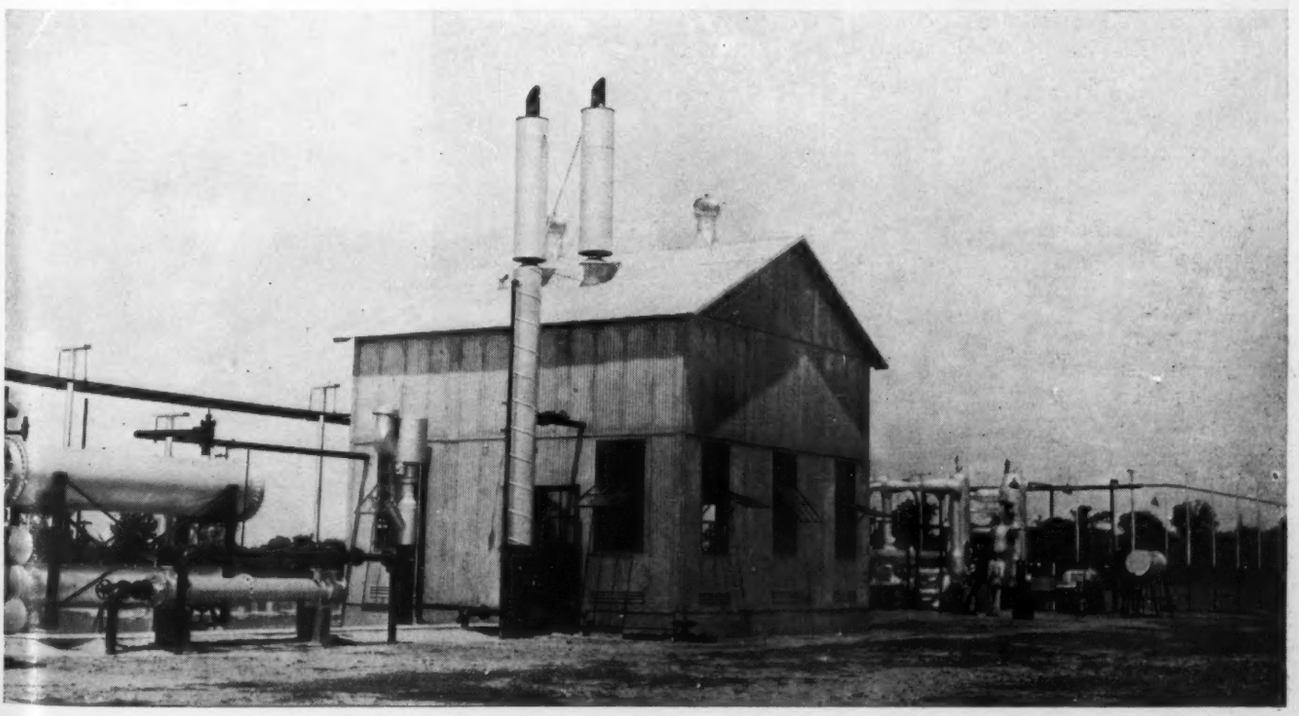
The ammonia and gas expansion unit. The process includes refrigeration resulting from the expansion of the gas, and also employs ammonia or other refrigerating mediums.

the reciprocating type. The plant being of an experimental design, it was thought advisable to keep the compressor work for both refrigeration and gas boosting within the same machine.

AUTOMATIC OPERATION

The plant is equipped for complete automatic control for operation and safety. An essential feature of a high-pressure plant is safety arrangements for operations. In this connection a three-button control system was installed and control button located at plant office. By pushing one button a master valve on the gas fuel supply and pilot line to the boiler is closed, and the same mechanism opens a snuff valve on a steam line to the fire box of the boiler. Pushing the second button grounds the engine magneto, stopping the engine compressor. Pushing the third button closes the stop valve on the main incoming gas line to the plant. This latter valve also operates automatically on a differential in pressure across the

This view of the general layout of the new type gas recycling plant at Cayuga, Texas, shows the compressor house in the center. In this building is a 400-horsepower engine-compressor. To the left are the ammonia and gas expansion units, or refrigeration units. To the right are the heat exchangers, high-pressure traps and pumps. Although invisible in the picture the cooling tower also is on this side of the compressor house.



valve, in that should a line blow out on the plant side of the master stop valve, the valve would close, shutting off the incoming gas from the field. All these valves remain closed until they are manually opened again. The engine-compressor is equipped with an automatic oil pressure and water temperature shutdown device, and the accumulator on the suction of the unit is equipped with a mercoid switch which grounds the magneto and stops the engine if liquids attempt to carry over into the compressor cylinders.

The laboratory is located conveniently with respect to the plant and office. It is equipped thoroughly so that tests can be made on all plant products and distillate produced from gas wells. Cold brine is circulated through the condensers for distillation work, eliminating the necessity of using ice. The gas, steam, air, water and ammonia are connected to the laboratory for convenience and control.

J. F. Pritchard & Company of Kansas City, Missouri, constructed the plant for the Tide Water Associated - Seaboard. Wm. H. "Jack" Vaughan was responsible for the design and origination of the process, and George L. Barker and Jasper C. Dennis, gas field engineers of the Tide Water Associated Oil Company, assisted in the engineering work.

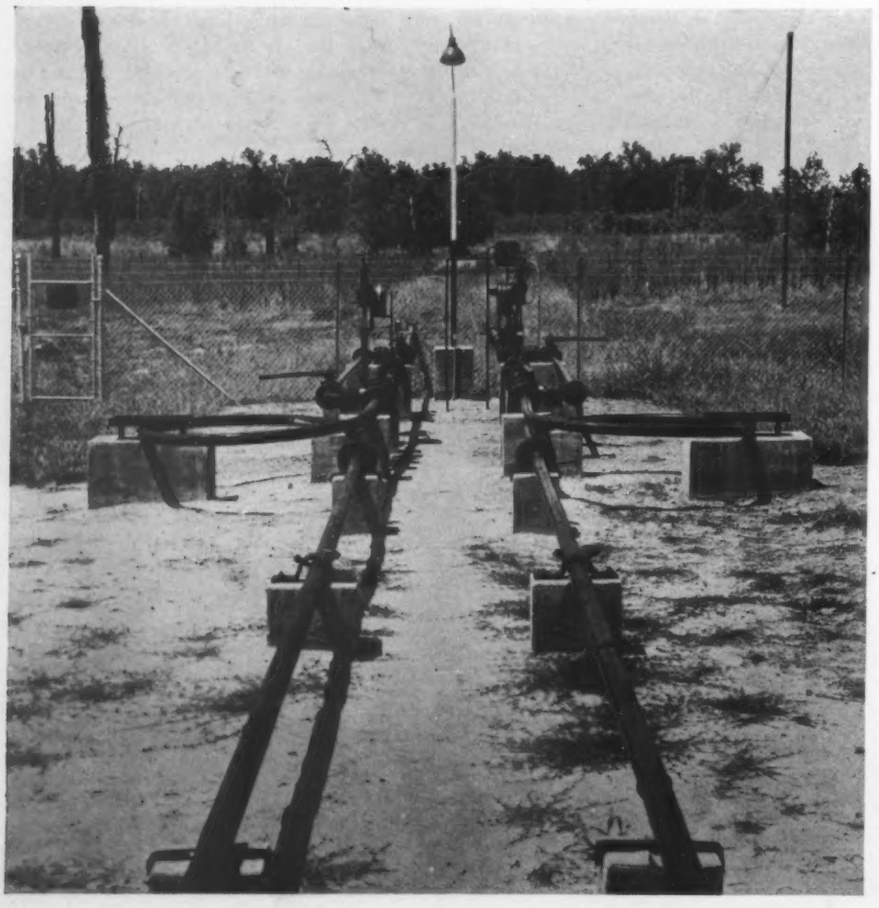
In charge of the operation of the plant are L. D. Phillips, plant superintendent, and T. R. Wade, general superintendent of the field.

The application for this type of plant would apparently seem almost unlimited, but there are many problems connected with such an operation both above and below ground, both as to safety and economics. First, a careful study and accurate survey of properties should be made before deciding on an installation. In many cases such a survey will reveal the impracticability of building a plant, especially on small properties. In Texas, only 25 percent of the well potential can be withdrawn from gas wells, and it might be found that there was not enough volume available on a small tract to justify a plant. The volume of gas that can be economically returned into an input well, and also the volume withdrawn, is controlled by permeability of producing formation. Second, the work is carried on at high pressure, and all equipment must be carefully designed and properly sized. Due to high pressures, there may be a tendency to design the equipment too small, which would result in decreased plant efficiency. To design the equipment larger than necessary for good results would prove to be rather expensive. For smooth operation, high pressure piping should be shop fabricated, and from a standpoint of safety, all high-pressure equipment should certainly be carefully inspected, stress relieved, and most of it X-rayed. Utmost precaution must be practiced during construction and each operation carefully guarded for the highest type of workmanship and skill.

The success of a plant of the above type depends on the thickness, porosity and permeability of the formation; the amount of condensible hydrocarbons contained in each unit volume of gas; and the above mentioned factors.

The present Cayuga plant proved to be capable of handling more gas than had been anticipated. Other wells will be connected to the present unit so that it may be thoroughly tested under full load.

Plant expansion will depend upon results of operation of plant under full load.



A meter set-up on incoming and outgoing gas lines in the Cayuga field, where gas is taken from the Woodbine producing sand and then returned to it under high pressure.

Refrigeration in Natural Gasoline Plants

J. C. ALBRIGHT

WITH gasoline plants operating under varied conditions, such as high percentage extraction of lower-boiling fractions, overload due to field conditions when larger volumes of gas are available than plant design anticipated, or adverse atmospheric conditions with high humidity and low wind velocity, successful stripping of the gas is a matter of increasing gas/oil ratio, or reducing temperatures on absorption oil. Assuming that peak circulation is being maintained and that oil and gas are being cooled as low as possible with water, then further reduction of temperatures must be obtained with refrigeration.

Warren Petroleum Corporation, Tulsa, Oklahoma, operates gasoline plants, both of the older type and those which are modern in every respect, where refrigeration is applied to obtain temperature reduction at various points, including absorption oil, stabilizer overhead condensate and plant products. When plants are constructed to include refrigeration of absorption oil, the chilling elements are a part of

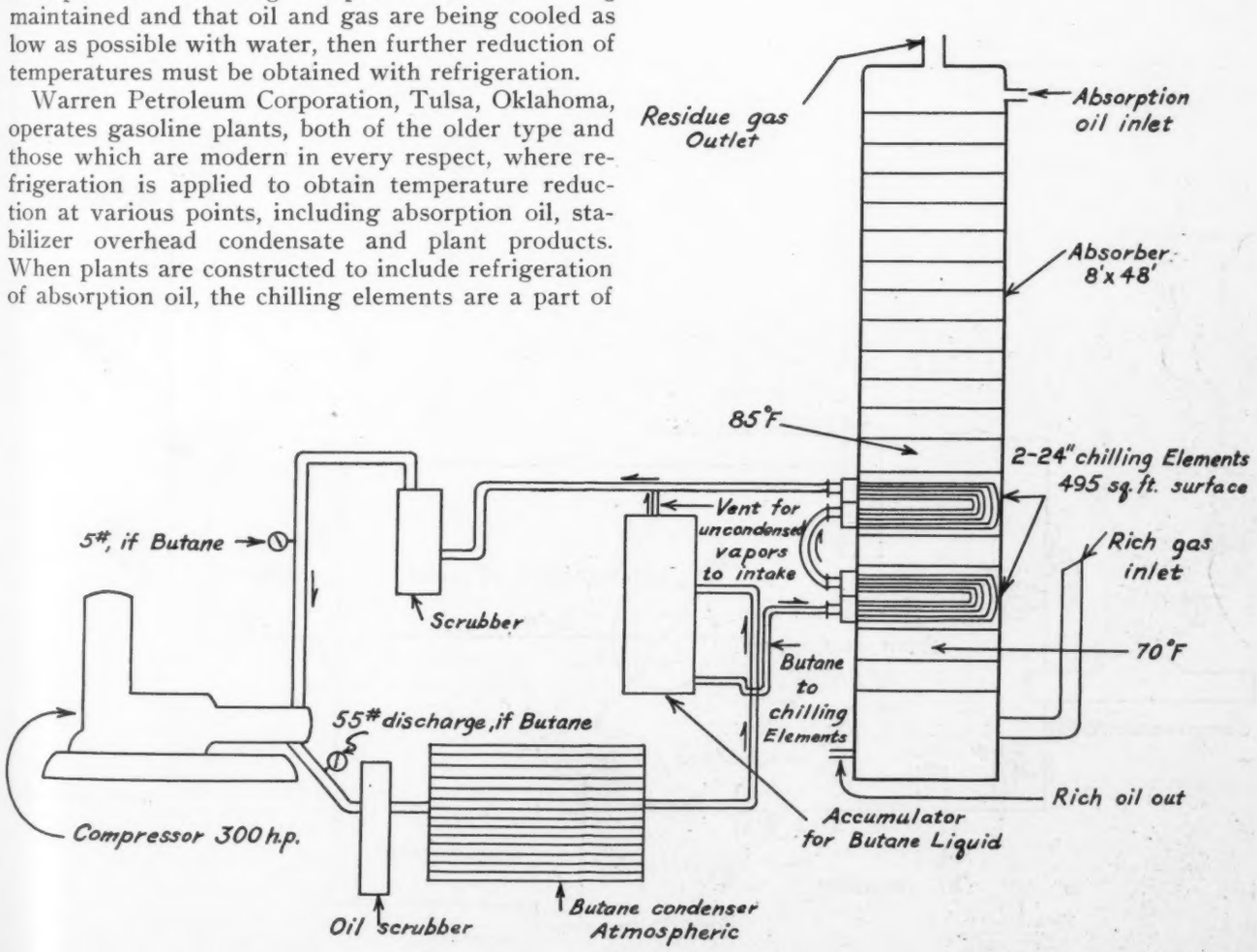


FIGURE 1
Flow diagram showing use of refrigeration in the absorber.

the absorber design, installed above the third and fifth trays, numbered from column base. With an 8 foot by 48 foot 8½ inch absorber, the chillers contain 245, three-fourth inch by 14 gauge hair-pin tubes, each bundle, or element, having approximately 400 square feet exchanger surface. See Figure 1.

Plants built without provisions for refrigeration are equipped with outside chillers for absorption oil, using six 10-inch x 5 feet shell-and-tube exchangers connected in parallel. Butane connections on the lower side of the shells with a header distributes the refrigerant equally to all units. Likewise, outlet connections on the upper side of the shells with a 12-inch header permit free passage of vapors without restriction. See Figure 2.

Outside application of refrigeration from a common system includes reduction of temperature on stabilizer overhead condensate when large proportions of propane are stripped from gas in absorbers, if stabilizer operation will not permit pressures on condensate accumulator to be carried high enough to prevent escape of vapors through safety valves, which may be caused by the volatility of product at lowered pressures. Stabilizers manufacturing 12-pound RVP natural gasoline under 150 pounds operating pressure frequently lose overhead condensate by insufficient cooling, which prevents liquefying all of the propane. A portion of the refrigerant, through a split stream, is used in shell-and-tube exchangers. The exchanger size is determined by the volume of vapors and temperature on the outlet of atmospheric coolers which are placed in vapor line as after cooler.

At the same time, if the product from the stabilizer base is insufficiently cooled to lower actual tank pressure, a similar exchanger is placed on the product line between the water-cooled units and storage vessels. When the refrigeration unit is designed with sufficient capacity to chill the product and absorption oil to desirable temperatures, part of the refrigerant is used to air condition the plant office building.

In plants designed with integral refrigeration the compressor which handles butane (commonly used when design permits) is rated at 300 horsepower, which is sufficiently large to provide a reduction in absorption oil temperature from 85 to 70° F. when circulation is at rate of 750 gallons per minute, and furnishing from .75 to 1.0 ton refrigeration per horsepower. The refrigerant is produced which permits most economical performance; and if butane is used,

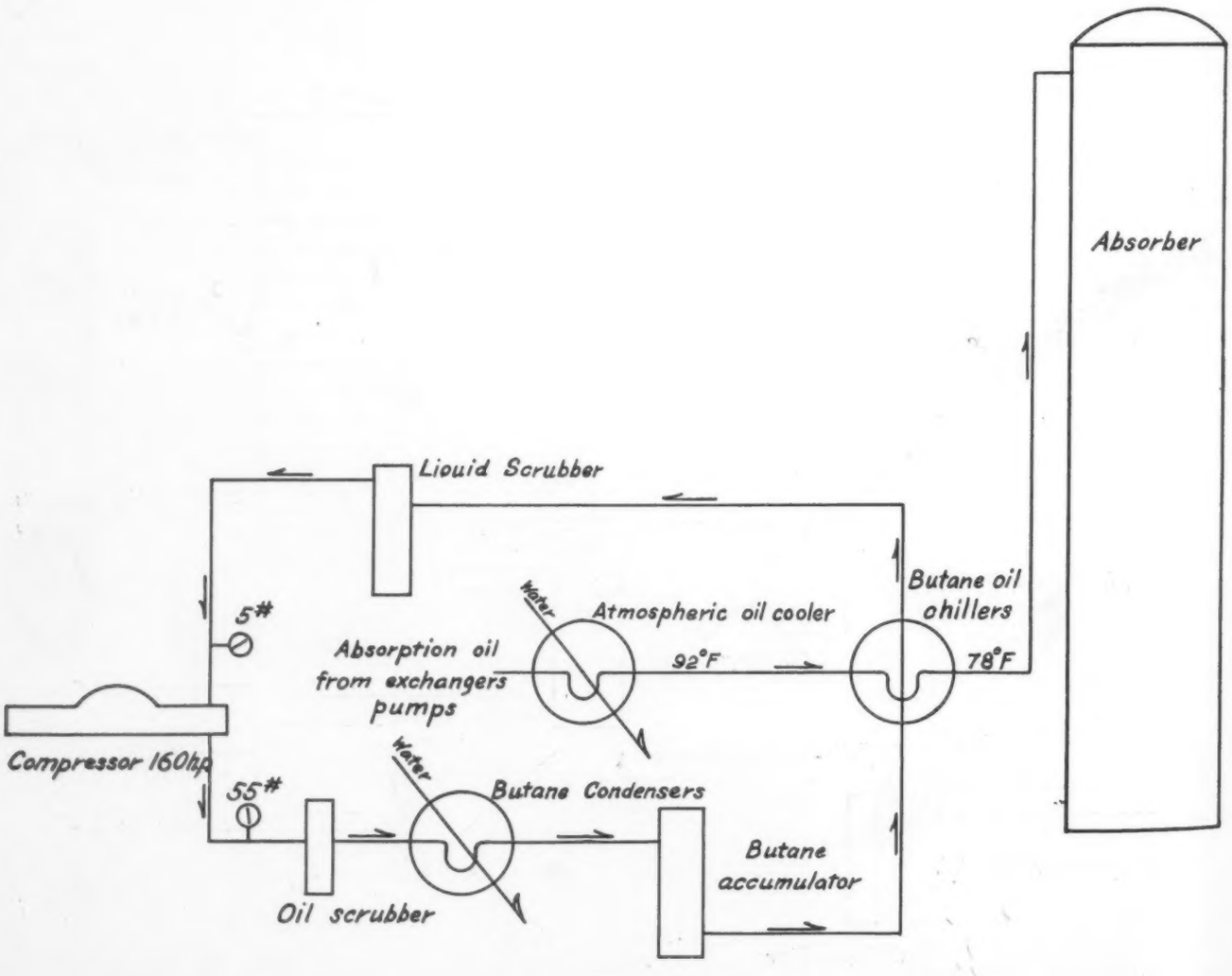


FIGURE 2
Flow diagram showing refrigeration outside of absorbers.

pressures from 55 to 70 pounds, gauge are all that are required to condense the vapors under average atmospheric conditions when water-cooled condensers are used.

Where refrigeration is installed in existing plants, the number and size of compressors available determine largely the type of refrigerant necessary to afford satisfactory reduction in process temperatures. Certain plants are so situated that a single horizontal gas engine-driven compressor is all the power available, which, if rated at 160 horsepower, can produce sufficient refrigeration to cool absorption oil from 92° F. on the stream from water-cooled units, to 78° F. on the stream to absorbers if the circulation is 150 gallons per minute. Figure 3 shows fractionator hook-up for chilling propane and butane.

Flow of the refrigerant through the closed system is as follows: From compressor (assuming that commercially-pure butane is the refrigerant used) at 55/70 pounds to lubricating oil scrubber, thence to atmospheric condensers and to accumulator drum. The drum is equipped with a liquid-level instrument which with remote control to the liquid valve at the inlet of the chilling units, maintains level in the accumulator for liquid seal. Drop in pressure throughout system, chillers and vapor lines depends upon rate of vaporization and size of piping but averages from 40 to 45 pounds to the liquid scrubber on the compressor intake header.

Advantages of refrigeration such as used by Warren Petroleum Corporation are: Lowered temperature on absorption oil in normal plant operation permits circulation to be reduced which in turn reduces load on oil pumps, boilers and preheaters. If plant is working above design of oil circulation capacity, greater recovery can be obtained with reduced absorption temperature. If desirable to recover all butanes and propane contained in the gas processed, the desired results can be obtained without increasing oil circulation rates. When stabilizer overhead condensation is unsatisfactory, due to atmospheric conditions or under-designed condensers, the after-chillers installed liquefy all products which may be accumulated under lowered pressures without re-vaporizing. When atmospheric conditions become adjusted to satisfactory operation without necessity of refrigeration, the compressors used for butane compression are placed on residue transportation system to boost gas pressure for distribution to pipe lines.

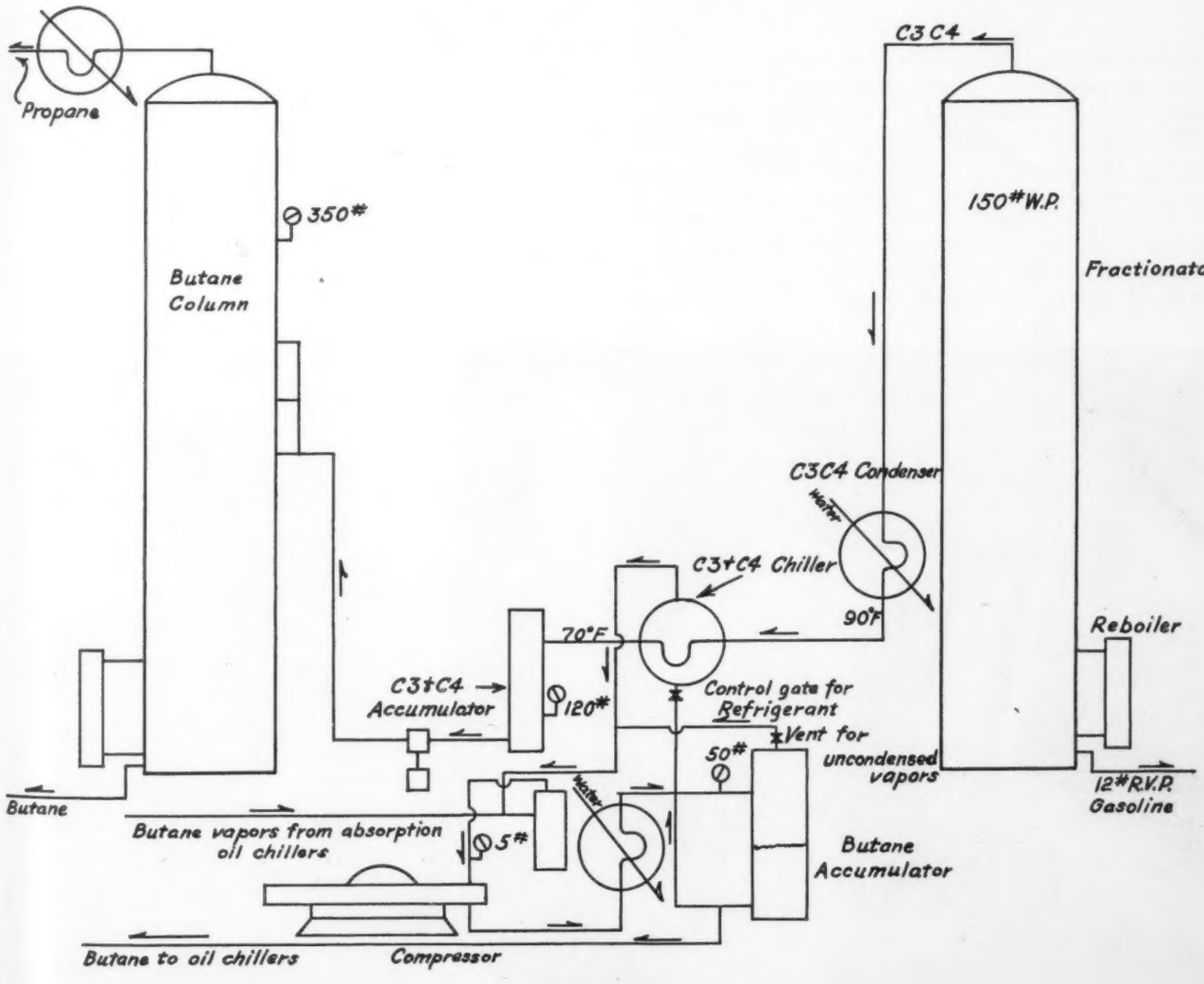


FIGURE 3

Flow diagram showing fractionator hook-up for chilling propane and butane.

Mercaptan Scrubber *and* Caustic Regeneration

Proves Efficient at Shreveport Plant

WHEN Atlas Pipe Line Corporation changed supplies of crude from East Texas to Louisiana and Arkansas fields, a different set of refining conditions were encountered, among which is the amount of sulphur compounds in cracked gasoline, including both hydrogen sulphide and mercaptans. The plant in which the cracked gasoline is manufactured is a double Pure-Alco process using topped crude as charging stock, that is reduced with straight-run gasoline and other products removed before cracking to fuel oil and high-octane gasoline in conjunction with a polymerization plant.

Treating cracked gasoline is more of a problem with high-sulphur crudes from Arkansas and Northern Louisiana than the gasoline from the sweet East Texas crude, and requires a greater amount of plumbite and caustic, as well as requiring a considerable amount of lead if mercaptans are not removed previous to doctor treating. Consequently, this company built a system through which the cracked gasoline is passed before rerunning for end-point control. The stream of cracked gasoline contains polymerized gasoline, combined in a stream as a composite product before rerunning, but is stabilized before flowing to treaters. The stabilized distillate has an average initial boiling point of about 86° F., a 50 percent point of about 236° F., and an end point of about 420° F., with an average of .001 percent H_2S, and about .046 percent mercaptans.

This material is run from the stabilizer base to working storage, from which it is pumped to caustic wash for hydrogen sulphide removal, with further caustic wash for mercaptan reduction. The octane number of stabilized, untreated distillate averages about 71.0 C.F.R.

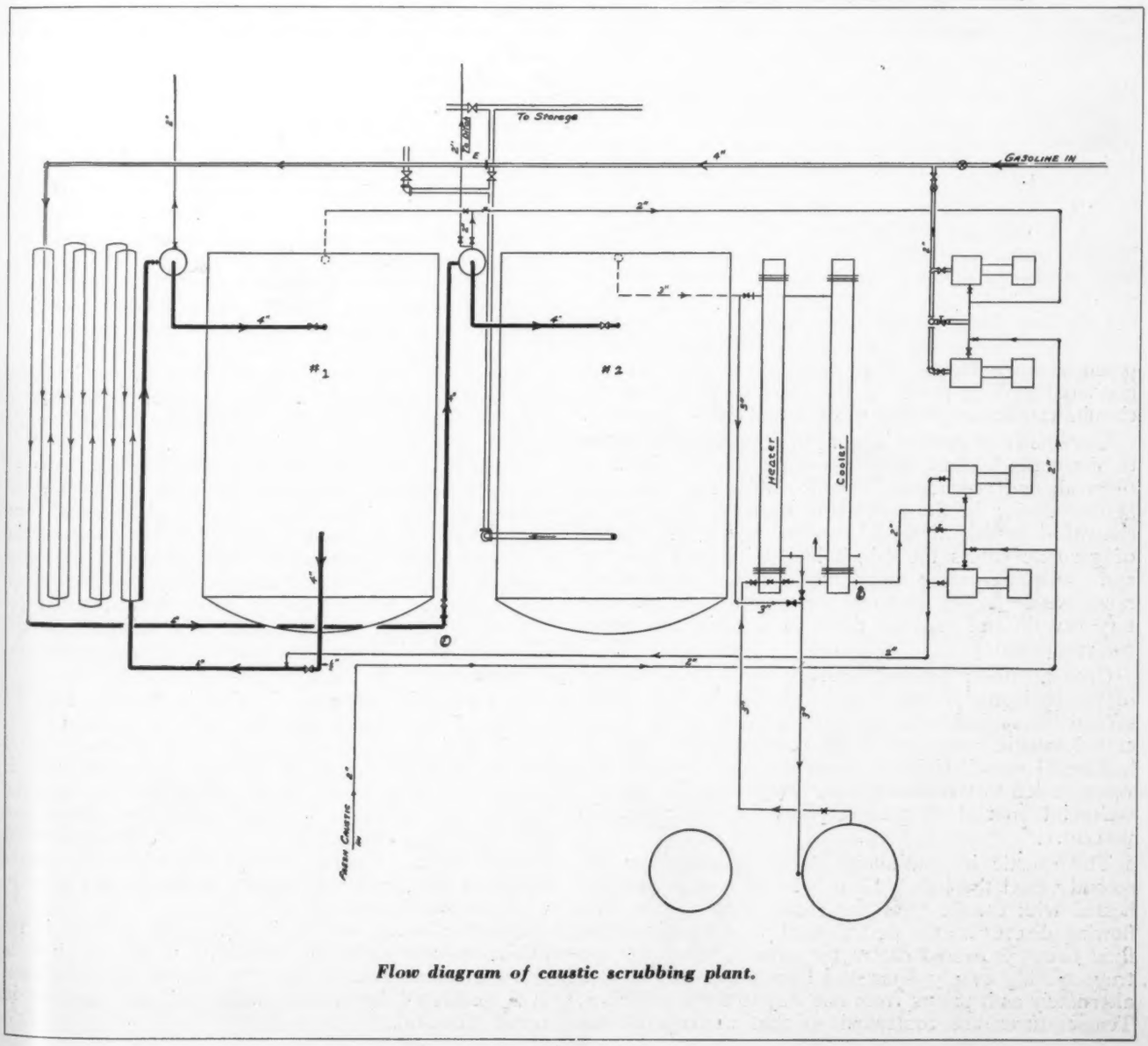
Overhead view of caustic treating plant of Atlas Pipe Line Company. Large horizontal vessels are treating units, vertical vessel at right is regenerator.

before entering the H_2S and mercaptan reducing units, and comes out of the plant for rerunning with about 70.8 C.F.R. octane. The H_2S is entirely eliminated from the distillate in the prewash, and mercaptans are reduced from about .046 percent to about .0233 percent when it is ready for rerunning.

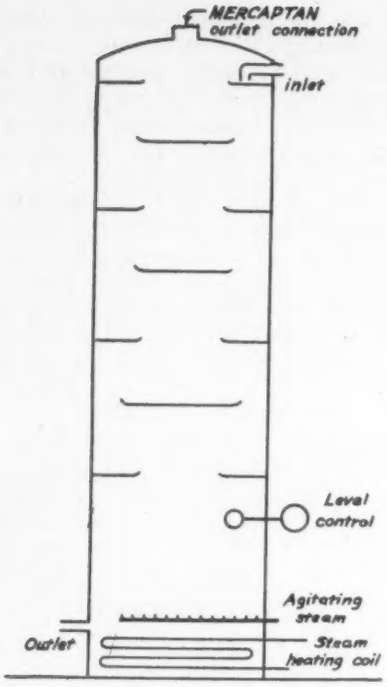
The plumbite requirement for stabilized, rerun distillate was about 462 pounds per 1000 barrels of gasoline treated, previous to mercaptan reduction. At this time, after being treated in the new unit with regenerated caustic, requiring only about 130 pounds of plumbite per 1000 barrels. The lead susceptibility is increased somewhat by mercaptan reduction, and for the same amount of lead used previously, the finished gasoline can be raised about .516 octane. Finished, treated, rerun gasoline, plus polymerization gasoline is being produced with 86° F. I.B.P., 256° F. at the 50 percent point, and 407° F. E.P., having an octane value of 72.3 C.F.R.

The caustic prewash used in the present set-up is not changed, and operates for H_2S removal in the same manner as formerly practiced. However, as the H_2S is removed in separated caustic solution, using liquid caustic cut to about 25° Be., the distillate is pumped directly to the mercaptan reduction plant. Materials that had accumulated in warehouse stocks were used to build the caustic contacting unit and regeneration plant. The unit consists of four pumps, two sets of contacting headers, two settling tanks, draw-off risers and a tower for regenerating the caustic continuously. The settling vessels are horizontal tanks, 11 by 20 feet, set near each other, yet providing sufficient space between them for ease in making connections and maintaining operation. The two exchangers—one as a caustic heater, and the other as a caustic cooler—are 12 inches in diameter and 16 feet in length, fitted with ¾-inch, 16-gauge tubes arranged for two pass. Headers and bypasses are attached so material in process may flow as desired; through both in series, or around either, or cutting out either or both as required.

The regenerator is a vertical vessel, 4 feet in diameter and 27 feet high, mounted directly on a concrete base with supporting flange. The interior is fitted with seven pans, each having an upturned lip rim to cause head of down-flowing caustic to spill evenly from the circumference. The inside is metallized with high chrome plating to prevent corrosion where caustic contacts the in-



Flow diagram of caustic scrubbing plant.



Caustic regeneration column.

side in the base of the column. Steam lines are connected to the regenerator in two points; one for live steam under boiler pressure for heating in closed coil, and the other point for exhaust steam for processing.

Each horizontal vessel requires a charge of about 85 barrels of caustic, reduced to 25° Be., containing about 6711.6 pounds per charge. Fresh caustic is always on hand in sufficient quantities to recharge the entire unit, with piping so arranged that the old charge may be withdrawn, and fresh charge placed in the circuit without shutting down the plant or interfering with operation. Pump connections are 2-inch throughout, with piping running from reserve supply to intake, and piping from various points in the plant connected so the circuits can be maintained on each unit while operating.

Gasoline from storage is pumped through a 4-inch line to the contact plant, after pre-caustic wash for H_2S removal, and regenerated caustic enters the same line before mixing in the contacting headers. The rate is controlled so that about 20 percent caustic per volume of gasoline enters the 4-inch line, with both gasoline and caustic entering horizontal mixing headers arranged in series for adequate treatment. From this battery caustic and gasoline flows to a horizontal vessel for separation.

Gasoline under process pressure flows from the top of the horizontal vessel to a 4-inch line leading to the second contacting unit, where it is mixed with regenerated caustic, and flows from contactors to a second horizontal vessel. Gasoline from the top outlet of this vessel is led to treated storage, ready to be re-run for end-point control with mercaptans reduced about 50 percent.

The caustic in continuous stream passes from the second vessel through a 12-inch by 14-foot exchanger, heated with caustic from the regenerator column, and flowing directly to the unit through 3-inch piping. The fluid being processed enters the column above the top tray, spilling evenly from the lipped rim and broken alternately as it passes from one tray to the next below. Temperatures are controlled so that mercaptans are driven from the caustic, and sufficient process steam is introduced to maintain gravity of solution and to prevent weight changing due to evaporation.

As heating is concentrated in the base of this vessel corrosion is prevented by coating with metal. Exterior equipment of this vessel consists of a liquid level controller actuating the circulating pump by remote control with steam delivered to circulating pump as required to hold level of liquid in the regenerator. Outlet piping for vapors generated within the vertical column consists of charge lines and vapor piping. Mercaptans and water vapor driven from caustic in process are led to plant lines for disposal away from the unit.

The plant is piped so that it can be used as a two-stage processing unit, keeping separate the two batches of caustic, or may be tied in as series operated treater. Caustic in the first vessel is usually circulated against control test until sufficiently spent, usually about 67 percent, when it is changed to the first tank and regenerated, with regenerated caustic passed back to the first from second tank to take the place of removed solution. When both, or either batch is sufficiently contaminated that further use is not desired, vertical scrubbers, or separators on each tank inlet may be used to withdraw caustic while the plant is in operation. Vertical columns for this purpose are 12 inches in diameter by 11 feet in length, set so that caustic and gasoline flow into them from the mixing contactors, with caustic breaking out in the base, with gasoline passing over to the horizontal vessel. When continuous circulation is maintained, without withdrawal of chemical, both pass through the vertical column to horizontal vessel undisturbed.

When the two vessels are operated independently of each other, caustic rates vary in each; as the first contact with fresh gasoline averages about 20 percent by volume, and second tank averages about 25 percent per volume. Two pumps are used for each circuit, one being for standby service while the other is operating. A single remote-control unit on the steam line, actuated by liquid-level instrument in the base of regenerator, handles pumps for the second tank, while the first tank is manually controlled. Equipment is now being installed that will be automatic in ratio control, permitting a certain amount of caustic to gasoline regardless of volume of material to be treated.

When it becomes necessary to dump either batch of caustic the line is opened on the base of the vertical column to pass a controlled volume of chemical, and in direct relation to amount handled by the pump on the system. As both gasoline and caustic enter in controlled volume, caustic withdrawn may be made up with fresh batch without shutting down, and when required replacement volume is taken from fresh caustic storage, old material will have been dumped to plant sewer and disposal lines.

The plant is automatic in that it requires little of operator's time to maintain after ratios have been established and temperatures equalized to desired control points. As flow of caustic through the regenerator is constant, a definite setting of live steam through the heating coil maintains temperature on the column, and as temperature and volume are constant, the amount of process steam is constant enough that when once established no change is required for several hours or days while on steady operation.

Gasoline being reduced in mercaptan content is returned to the plant for rerunning, after which it is given a second caustic wash to remove any additional H_2S generated by heating sufficiently to vaporize in rerun tube still.

Mercaptan and Hydrogen Sulphide Removal by Caustic Scrubbing

Talco Practice

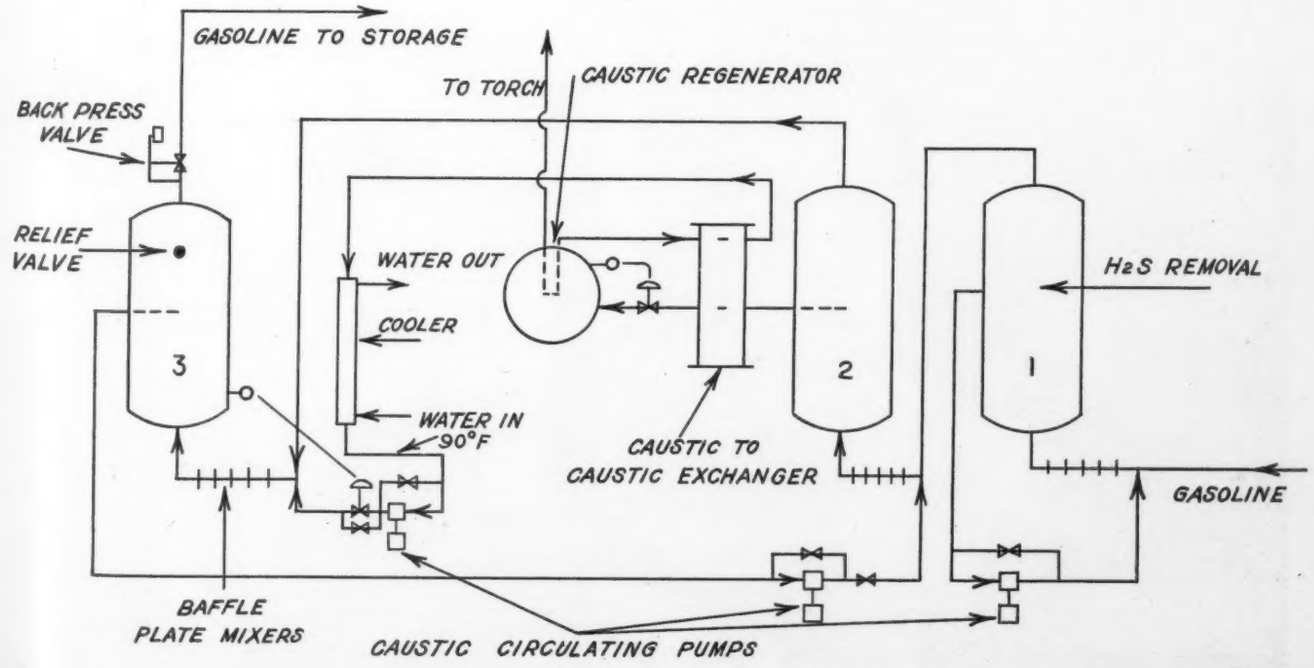
J. C. ALBRIGHT

PRESSURE distillate manufactured from heavy Talco asphaltic crude by cracking either gas oil or residuum from straight-run distillation contains both hydrogen sulphide and a high percentage of mercaptans. Treating with doctor solution is a difficult operation when a doctor-sweet and non-corrosive product is required. Talco Asphalt & Refining Company, Mt. Pleasant, Texas, built a preliminary caustic scrubber soon after the Dubbs cracking plant was erected in 1937, which was effective in eliminating hydrogen sulphide, but the product continued to be difficult to treat in the final sweetening plant, and the cost of chemicals was higher than desired.

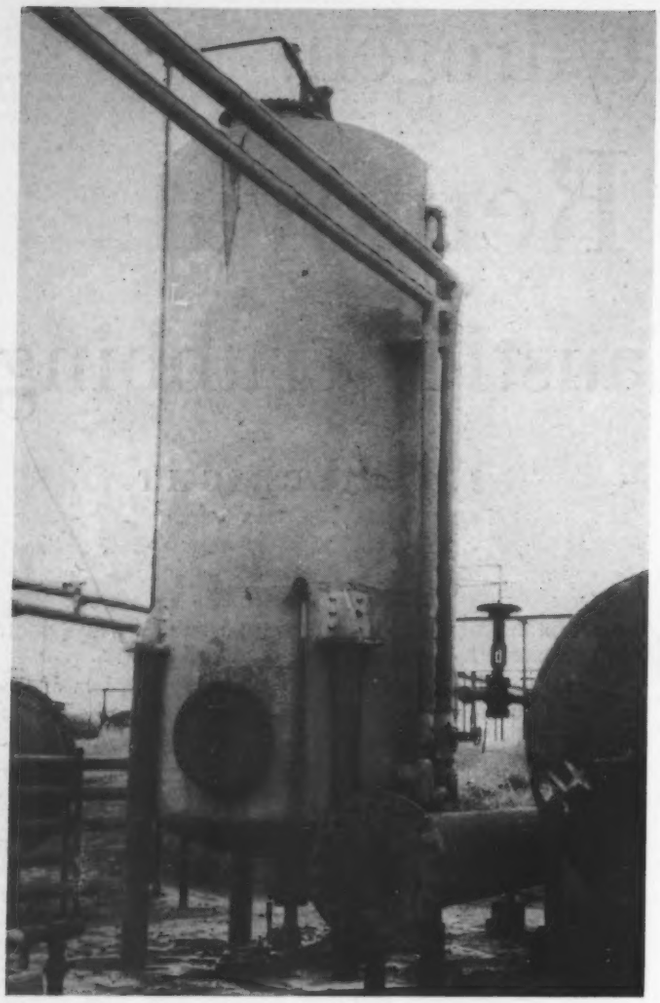
Caustic soda has long been used for removal or reduction of hydrogen sulphide, but only recently has successful application been made with caustic soda for reduction of mercaptans. The raw, stabilized gasoline manufactured at this plant contains about .10 percent mercaptans, about .22 percent total sulphur, and about .002 percent hydrogen sulphide.

The system employed by the company consists of two separate units; the first a conventional method of circulating a 14° Be. caustic soda solution in a continuous cycle with the stabilized pressure distillate, with the chemical employed until it has become about 75 percent spent. The equipment in this step of treating includes a receiver for both caustic and distillate, a caustic circulating pump, adequate contactors, and operates at the temperature at which the product of cracking enters the treating system. The receiver for both the chemical and distillate is a drum 5 feet in diameter and about 12 feet long, horizontal on concrete piers only a short distance from the pressure distillate stabilizer so that process pressure in that equipment can be employed in passing the product through the treating units.

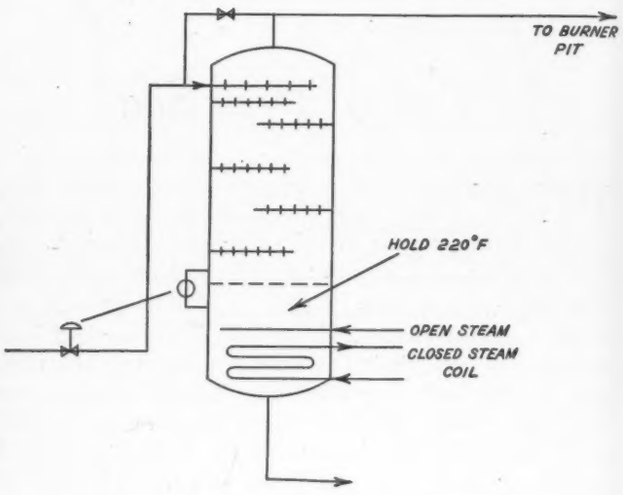
Approximately 10 barrels of caustic solution is intro-



Layout of treating plant at Mt. Pleasant which is used for H_2S removal and mercaptan reduction.

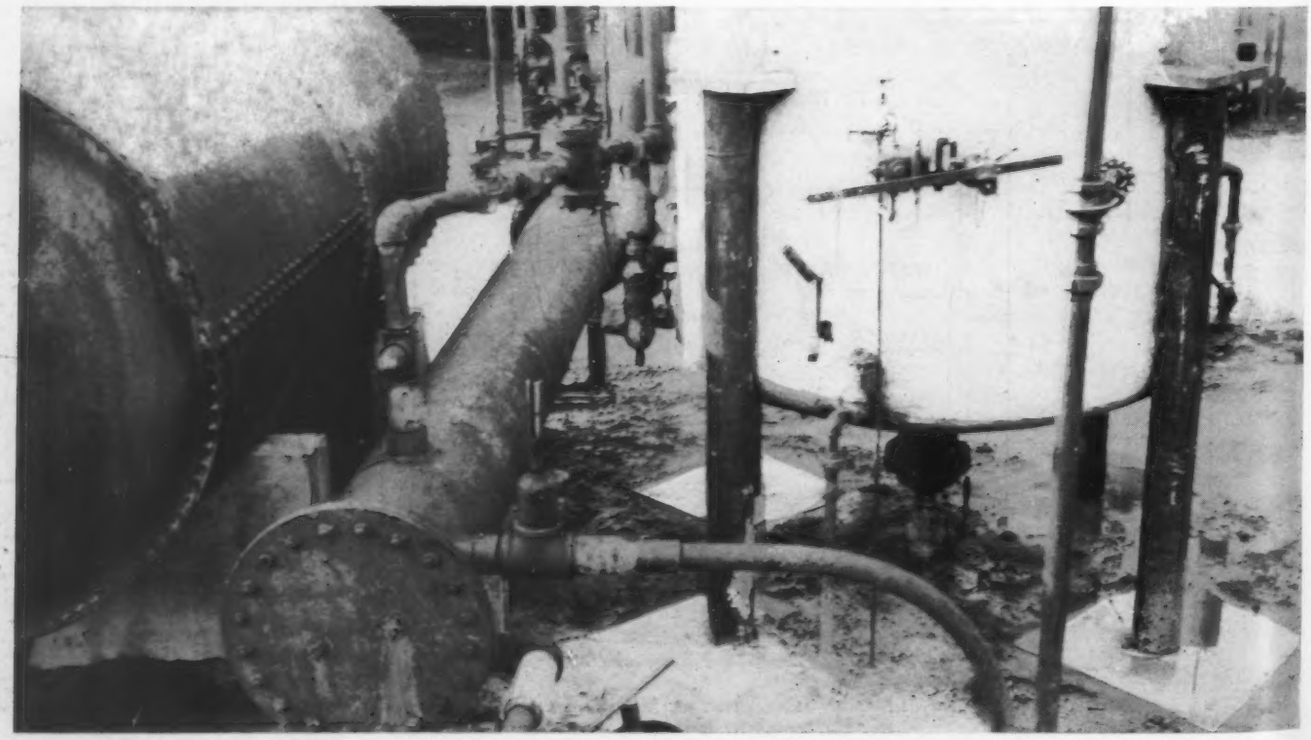


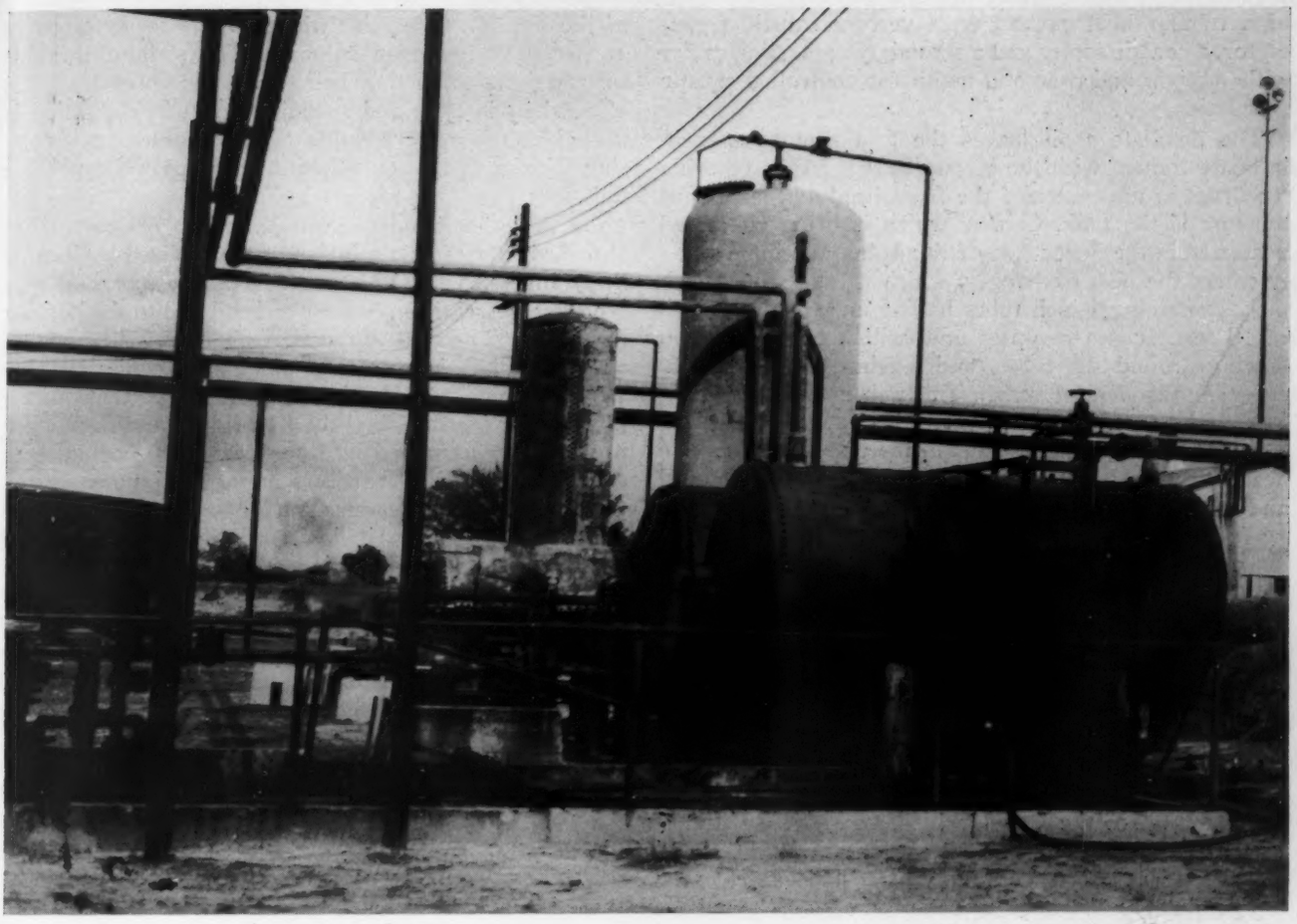
Vertical regenerator with tubular heat exchanger between vessel and horizontal tank at right. Gauge glass shows level of solution in vessel while regenerating.



Sketch shows operating details of regenerator.

Below: Detail of exchanger connections, and liquid level control on regenerator base.





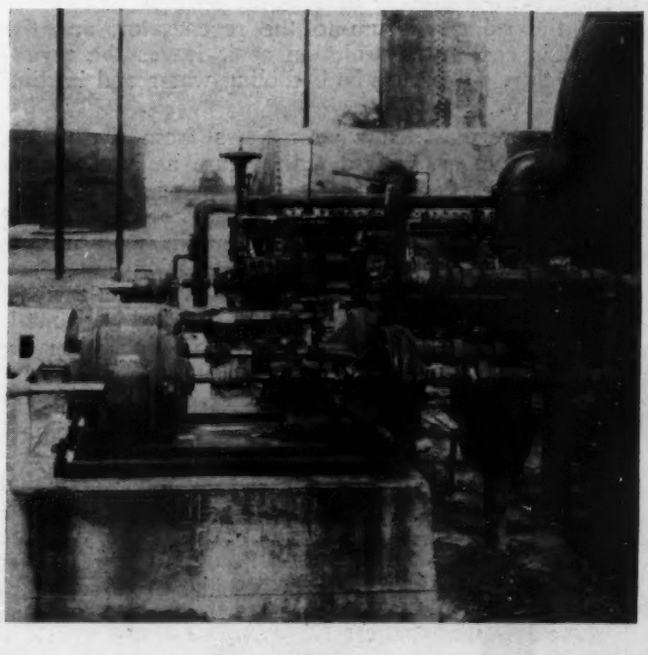
Treating plant of Talco Asphalt & Refining Company, showing H_2S removal vessel in foreground, with caustic regeneration units and vertical column with insulation.

duced in the system, and is effective for normal operation for about two weeks. The chemical deteriorates at a rate of about 5 percent each day, with normal cracking operation, and at the end of about 15 days, it is withdrawn and discarded. With about 25 percent effective hydrogen sulphide removal still remaining, it is thought that more effective over-all treating can be obtained by discarding this material and replacing with a fresh mixture, than run the risk of small amounts of hydrogen sulphide passing through the treater.

The mixing device used in this plant to obtain an intimate contact between distillate and chemicals is conventional installation, placed as near the inlet of the drum as practicable and laid under the ground, with the chemical and gasoline entering the drum in the center of the front head. Caustic is withdrawn from the vessel with a motor-driven centrifugal pump through a connection in the lower side of the shell, and circulated continuously. An adequate by-pass is installed on the piping of this pump so the ratio of chemical to distillate can be maintained, and the rate of caustic circulation is between 25 and 30 percent by volume of the distillate treated.

The hydrogen sulphide-free cracked gasoline leaves the top of the drum under process pressure and enters the mixing device of the second system for the reduction of mercaptans. The contacting equipment for caustic and gasoline at this drum is similar to that employed in the hydrogen sulphide removal unit, and a pump identical to the first is used for caustic circulation. The drum used in mercaptan removal is identical to the first vessel, and approximately the same amount of chemical is contained in it; being about 10 barrels of 14° Be. solution. The remainder of the equipment used consists

Motors and centrifugal pumps that handle caustic solution.



of a tubular heat exchanger, a vertical caustic regenerator, a caustic cooler and a secondary contacting mixer with receiver and a second pump for controlled caustic circulation.

The distillate as it leaves the first drum passes in intimate contact with the second soda solution, entering the drum in the center of the front head and leaving at the top of the tank. Caustic which is being circulated passes from the lower side of the drum, and immediately enters the heat exchanger, which is made of 16-inch pipe, containing 1-inch tubes having an effective length of 10 feet. It is a two-pass unit, with the cold solution flowing around the tubes, and leaving to immediately enter the regenerator vessel. This unit is a vertical tank, 5 feet in diameter and 15 feet in height, equipped with 5 perforated side-to-side pans in the upper section. The heated caustic is introduced near the top of the vessel and is distributed across the inside of the vessel with a perforated distribution pipe. The base of this unit is maintained with about 15 barrels of soda solution to cover a closed-steam heating coil, and an open process coil for exhaust steam introduction.

Sufficient steam is kept flowing through the closed heating coil to obtain a temperature of about 220° F., or slightly above the boiling point of 14° Be. caustic solution, and only a small volume of open steam is required for processing the chemical. A liquid-level controller is attached to the regenerator to maintain a definite level in the vessel, which may or may not be used, and is sometimes by-passed. The mercaptans and water vapor released from the caustic solution leave the top of the vessel through a back-pressure valve, and are piped to a burning pit for disposal. The regenerated caustic solution leaves the bottom head of the vessel, flowing through the tubes of the heat exchanger for partial cooling; thence to the water cooler, which is located nearby. This unit is built by using 5 sections of 4-inch pipe, the length of a standard joint, in which 2-inch pipe is inserted. Adequate connections are attached to the cooler to insure regulation of flow, with water circulating in the annular space between the 2- and 4-inch pipe, and the caustic solution passing through the 2-inch. Two objectives are reached in the primary exchanger; the first by heating the solution as it flows from the primary drum to the regenerator, and the second is cooling the solution as it leaves the regenerator, thus conserving both cooling water and heating steam.

As the regenerated caustic flows from the water-cooled exchanger, with a temperature as low as consistent with existing facilities, it is picked up by a 1½-inch pump, driven by an electric motor and passed through the secondary contacting unit, with mixing devices similar to the foregoing installation, but entering a receiver drum with the gasoline, which is a vessel 5 feet in diameter and 15 feet long, installed horizontally. The first contacting pump takes suction from the lower outlet of the secondary vessel and pumps the solution to the primary unit, thus completing the cycle.

The object in building a two-stage mercaptan removing system is that the characteristics of this crude prevents optimum reduction of this objectionable compound in a single contact unit. The comparatively low percentage of hydrogen sulphide is removed easily in the first, or caustic-wash operation before the distillate is passed to the secondary units, and the chemical circulated is observed closely to prevent an over conversion of the solution to a point where it will not be effective in removing hydrogen sulphide. The sodium sulphide formed in the reaction being a stable compound, not affected by heating and steaming, must be discarded in this plant when the treating agent becomes sufficiently sluggish that hydrogen sulphide might pass through the unit.

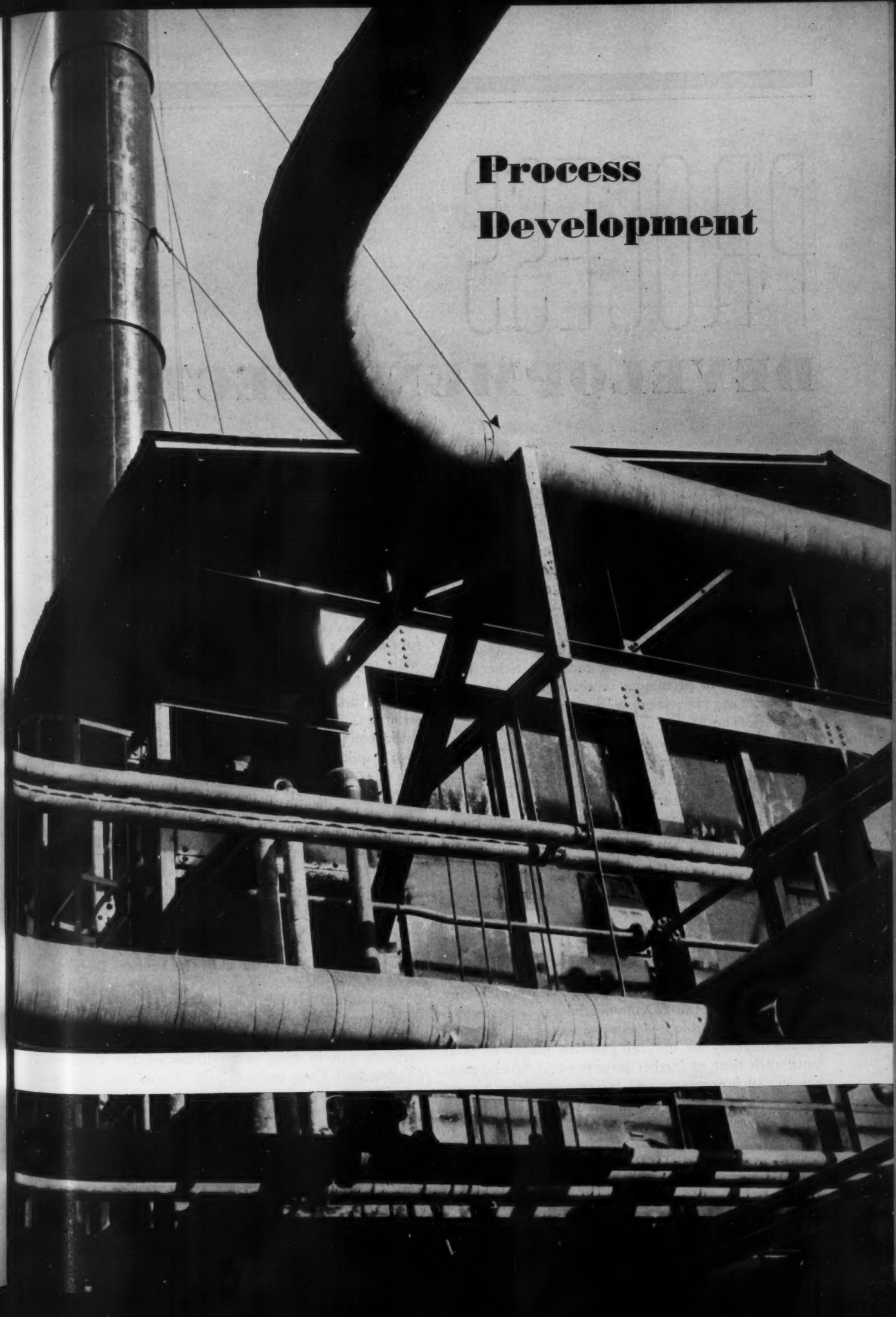
On the other hand, the low-boiling mercaptans when absorbed in a caustic solution are hydrolized by heating the solution in the presence of water vapor and pass from the vessel through the overhead line to the burning pit. Up to 60 percent of the mercaptans may be removed when the plant is operating under ideal conditions, but a fair average of reduction is about 50 percent. In the process of regenerating the caustic solution sufficient pressure is maintained in the system from beginning to end that the distillate flows in a continuous stream without the aid of pumps, and upon leaving the secondary contact drum it flows to run-down storage for further disposal and treating with doctor solution.

The factors which control the effective reduction of mercaptans in this plant apparently are the amount of compounds in the distillate and the ratio of caustic solution to the stream of pressure distillate. With 0.10 percent of mercaptans in the gasoline, the effective reduction is obtained with a ratio of from 1:4 to 1:3, caustic solution to distillate processed. The temperature at which efficient absorption of mercaptans from the distillate occurs is 95° F. or lower, it is said, and efforts are made to reduce the temperature of the caustic while flowing through the water-cooled exchanger to that point, or lower. With an unlimited supply of reasonably cool well water, the temperature of the caustic in the first contact from the regenerator is about 85° F.

No attempt is made to regenerate the caustic solution by removing the sodium sulphide from the hydrogen sulphide solution, and, as stated above, it is merely dumped in the sewer when its effectiveness becomes doubtful. In the mercaptan-treating unit, the life of the solution seems to depend upon the thoroughness with which the hydrogen sulphide is removed in the first stage, as the stable sodium sulphide impairs the absorption of mercaptans. So far, the replenishing of mercaptan-removing caustic solution has not been necessary, and the gravity of the material can be controlled by handling the open steam coil so more or less dilution occurs as the closed steam coil drives off part of the water from the 14° Be. caustic.

This plant is arranged so it may be operated continuously, regardless of final disposition of the gasoline, and when the sweetening plant is shut down, the product is run to storage in the tank farm while the cracking plant operators care for the unit. While it is practically automatic in operation, requiring a minimum amount of observation after being balanced off in starting, the operators on various shifts make their rounds to determine levels of treating solution in the various vessels.

While levels are maintained by automatic instruments on the regenerator vessel and the secondary contacting drum, bypasses on each pump can be set to prevent over-circulation of caustic solution. The centrifugal pumps that circulate caustic solution have sufficient capacity to over-circulate if not controlled, which would impair the system by reducing the time necessary to contact, regenerate and cool the solution before beginning the cycle again.



Process Development

PROCESS
DEVELOPMENT SECTION

The Refiner presents in the pages following, as a supplement to its widely known annual Process Handbook, published annually since February, 1932, a section devoted to Process Developments. In this section there is a group of engineering descriptions, flow diagrams and photographs of 24 commercially operating processes which were not available at the time of publication of earlier editions, or which have been largely improved recently.

The information incorporated in the following process descriptions has been compiled either from the literature of petroleum or through the cooperation of the organizations owning and controlling the processes. The 24 engineering descriptions include 6 polymerization and hydrogenation processes, 3 filtration processes, 1 propane process, 7 chemical refining, recovery and de-salting processes, 5 gas purification processes and 2 natural gasoline processes. Several of the processes presented in the following pages have been described in previous issues of the Process Handbook, but a review of the material will disclose that the processes are so markedly improved and changed that present design and operation methods easily justify repetition here.

The purpose of this publication is not to correlate all available process information under one cover, such as was the purpose with earlier editions. Rather, in this instance the aim is to correlate engineering data relative to the 24 commercial processes which the industry has adopted as a permanent department of the refinery or natural gasoline plant—at least until such time as further progress and development renders such processes and systems obsolete. A comprehensive correlation of process information is available in the 1938 edition of The Process Handbook, in which work 54 different process descriptions which cover virtually all phases of refining and natural gasoline manufacture were published. Copies of the complete Process Handbook, 1938 edition, can be secured through the Book Department of The Gulf Publishing Company, 3301 Buffalo Drive, Houston, Texas; Price $1.00.

The Process Development Section, immediately following, is designed to bring to those concerned with process work and its development, valuable information relative to the individual processes, their purpose and functions, as well as design and construction. The photographs used where available and the accompanying flow diagrams of the processes, give a quick picture, handily arranged for comparison or study of process operation.

In practically all instances where individual process units are presented, not only is the primary equipment shown in the drawing or editorially presented, but the use of practically all types of auxiliary equipment is shown and discussed. This additional detail enhances the value of the work to the student of processes; the subject matter indicates the necessity of the auxiliaries and the manner of their application to the given process.

The material incorporated in the Process Development Section, has been secured through the cooperation of manufacturers and owners of the patented processes, and has been prepared for the exclusive use of The Refiner and Natural Gasoline Manufacturer, which in turn is publisher of the Refinery Catalog and Process Handbook. Permission for reprinting in any form must be secured from the publisher.

INDEX TO PROCESSES

POLYMERIZATION

POLYMERIZATION PROCESSES

	Page
Pure Oil Thermal Polymerization Process	444
Shell Catalytic Polymerization Process	446
Shell Catalytic Hydrogenation Process	448
Thermal Polymerization Process	450
U.O.P. Catalytic Polymerization Process	452
U.O.P. Isooctane Process	454

FILTRATION

FILTRATION PROCESSES

Continuous Contact Filtration Process	456
Percolation Filtration Process	458
X-YTE Percolation Filtration Process	460

PROPANE

PROPANE PROCESS

Sun-Alco Propane Process	462

CHEMICAL REFINING

CHEMICAL REFINING PROCESSES

Copper Sweetening Process	464
Howard Treating Process	466
Lachman Treating Process	468
Stratco Pbs Sweetening Process	470
U.O.P. Treating Process	472

RECOVERY PROCESS

Bayway Chemicals Recovery Process	474

DE-SALTING PROCESS

Petreco De-Salting Process	476

GAS PURIFICATION

GAS PURIFICATION PROCESSES

Diethylene Glycol Purification Process	478
Girbotol Purification Process	480
I. G. Alkacid Purification Process	482
Koppers Phenolate Purification Process	484
Shell Phosphate Purification Process	486

GASOLINE

GASOLINE PROCESSES

Absorption Oil Refrigeration System	488
Pressure Maintenance Process	490

Pure Oil Thermal Polymerization

THE Pure Oil "Thermal Process" for the production of high octane gasoline by the polymerization of hydrocarbon gases is so known because the reaction is made to take place by heat alone and without the use of catalysts. This process has been in the course of development for nearly 10 years by the Pure Oil Company, under the direction of C. R. Wagner. This information is presented here through the cooperation of Alco Products Division of American Locomotive Company, 30 Church St., New York, N.Y.

Polymerization in a broad sense may be defined as the union of two or more molecules of a substance to form a larger molecule, the latter being called a "polymer." This reaction, while known for many years received very little attention by the petroleum and natural gas industries. The main reasons for this lack of commercialization are to be found by studying the history of other refining operations. Such a study reveals the fact that cracking has been responsible for the production of low molecular weight olefinic gases, in large quantities, which are ideal raw material for the polymerization process. While these gases have been used to a limited extent for the production of alcohols, sufficient data on polymerization of these gases was not available for the safe design of commercial plants. The second stimulus for polymerization commercialization came from the refining and natural gas industries which adopted stabilization plants for removing Butane and Propane from so-called finished gasoline. This development resulted from demands made by the motoring public and from automobile manufacturers that vapor-lock tendencies of gasoline be removed. By removing the vaporlock producing compounds, propane and part of the butane, there was made available a large quantity of low molecular weight, normally gaseous hydrocarbons, which could not be marketed. This surplus of available raw material has been responsible for the demand for some process which would transform these gases into liquid motor fuel which has enjoyed a good outlet year after year.

The Pure Oil Thermal Process of polymerization, when operated at the lower temperature range produces a liquid gasoline consisting of aromatics, naphthenes, olefins and some paraffins. By operating at a higher temperature level, a product can be made which consists of 95 percent aromatics and five percent of other cyclic compounds. These two products, both suitable as gasoline or gasoline blending materials can be produced from the same raw material. This flexibility is made possible because of the fundamental design of the process which is based upon the principle of separately controlled pyrolysis and reaction coils. By this system it is possible to control to within narrow limits, the extent of the pyrolysis of the charged gas and to separately and accurately control the actual polymerization reaction.

For a unit where liquefied normally gaseous hydrocarbons is available and where it is desirable to separate the polymerization plant distillate from the gasoline normally received from the gas plant, the installation would be generally as shown by the flow chart on the opposite page. For a design of this character the feed received from the stabilizer is accumulated in the feed tank "A" and is pumped by "B" through pyrolysis coil "C" which operates within the range 975-1300°F. and at various pressures. The temperature maintained in this coil is definitely controlled so that the gases will be activated and their characteristics modified to suit the requirements of the reaction coil (polymerization step) to produce the predetermined quality of polymer distillate. The charge then enters the reaction coil "D" which is accurately controlled as to temperature and the reaction products upon leaving the coil meet cooler material, either gas or liquid which reduces the temperature of the mixture to such a degree that further polymerization is arrested. The mixture then flows to fractionating tower "E" where fractionation takes place. The polymer distillate produced is removed from the tower as a side-stream and is stabilized to specifications in "F" and is removed through line "G". The gas is taken overhead from the tower "E," is cooled and partially condensed, and the condensate is returned to the top of "E" as reflux liquid. Any uncondensed gases are fed to the absorber "H" where the condensibles are removed. The dry gas leaves the plant through line "I". The rich oil is pumped to a still and the heated material is either flashed into the main tower "E" and the condensibles removed with the regular poly distillate or they are separately recovered and used as recycle stock. The residue leaving the fractionating tower "E" is either sent to the cracking stills or stripped of light constituents in a separate stripper.

The polymer gasoline produced may be made to vary over wide limits according to the conditions employed. In general, the higher pressure lower temperature method of operation produces the maximum yields of gasoline which has a high volatility. By operating at higher temperatures and lower pressures the gasoline can be produced with a low volatility, due to the aromatic nature of the product, and with a lower yield than is obtained under the first conditions. With this wide degree of flexibility one plant serves for polymerizing all types of charge stocks with widely varying characteristics and ratios of saturates to unsaturates.

RESIDUE GAS
RECYCLE CONDENSER
FRACTIONATING TOWER
STRIPPER
REBOILER
STABILIZED POLY DISTILLATE
GAS OIL TO CRACKING UNIT OR STRIPPER
COOLER
REFLUX ACCUMULATOR
ARRESTER
FEED TANK
PYROLYSIS COIL
POLYMERIZATION COIL
POLY FEED
STABILIZER
STABILIZED GASOLINE
RICH OIL TO STILL
FEED
ABSORBER
LEAN OIL
A
B
C
D
E
F
G
H
I
NOTE:
DOTTED LINES INDICATE EXISTING INSTALLATION
PURE OIL THERMAL POLYMERIZATION PROCESS
COURTESY, ALCO PRODUCTS DIVISION OF AMERICAN LOCOMOTIVE COMPANY

Shell Catalytic Hydrogenation

OCTENES TO OCTANES

A CATALYTIC hydrogenation process has been developed by the Shell Companies which is simple, economical, and particularly adapted to the hydrogenation of octenes produced by polymerization of butylenes. The process operates at low pressure (below 4 atmospheres, gauge) and at a temperature not exceeding 200°C. (392°F.). The process effects substantially complete hydrogenation, and produces thereby high octane fuels low in acid-heat number and ideally suited for manufacture of high octane aviation gasoline.

The commercial process produces octanes of 98-100 octane number by direct polymerization of an octene mixture prepared by butylene polymerization, which process is described elsewhere in this issue under the title "Catalytic Polymerization by Sulfuric Acid." The hydrogenation process is also suited to other feeds than the octene mixture, including di*iso*butylene and tri*iso*-butylene. The hydrogenation process operates in the vapor phase and employs low pressures and temperatures. These mild conditions are employed as the result of development of a suitable active nickel catalyst which is supported on porcelain.

The unformed catalyst is a hydrated nickel nitrate impregnated in porcelain. The nitrate is decomposed to nickel oxide, and then reduced to metallic nickel in a stream of hydrogen. After formation the catalyst is maintained in a hydrogen atmosphere when not in service. The activated nickel catalyst is susceptible to poisoning, particularly by sulfur. Carbon monoxide and oxygen produce temporary loss of activity, which can be restored by reactivation in place. Sulfur produces permanent loss of activity, thus sulfur content of the octene feed must be kept at a minimum and this can be done by proper treatment of the butylenes prior to polymerization. Spent catalyst can be used for pre-treating the octene feed to reduce sulfur content prior to contact with active catalyst. Experience shows that in plant operation 1000 gallons of finished *iso*octane are produced per pound of nickel charged to the catalyst chambers.

The source of hydrogen for plant operation should be free of sulfur which can be removed by a simple treatment of the hydrogen gas stream. Convenient sources of hydrogen are the pyrolysis of natural gas and the dissociation of ammonia. A process for the production of cheap hydrogen, free of impurities with poison nickel catalysts, has been developed recently by the Shell Chemical Company. This gas contains 85 percent hydrogen, with only methane and nitrogen as impurities, both of which are inert and their presence in this amount is not objectionable in the process.

The catalyst, when activity is decreased to a certain point, is reactivated in place to increase its life. The bed is purged of hydrogen, air is then introduced for 4 to 12 hours, and the oxidized catalyst is again reduced with hydrogen. Initial activity is not restored but by applying the reactifying operation two to four times the life of the charge is increased by 150 percent. Activity declines slowly after each reactivation and ultimately the charge is removed from the converters and regenerated.

The equipment for plant-scale operation of the hydrogenation process is shown in Figures 1, 2, and 3, which are skeleton flow diagrams showing only the major pieces of apparatus. The principal problem in design of the catalytic converters is that of heat removal. To facilitate rapid heat transfer the catalyst is placed in 3 inch diameter vertical tubes, arranged in bundles by rolling the tubes into end plates, with circulating hot fluid maintained around the tubes. The circulating hot fluid is maintained at the desired reactor temperature, and is led from the reactors through a cooler, with a controlled by-pass—maintaining thereby a constant temperature on the hot fluid in the converters. For catalyst formation and reactivation, which are carried out at higher temperatures, a separate hot-fluid circulating system supplied with a furnace is used. When several converters are in use, it is possible to retain some in service while others are being subjected to catalyst formation or treatment.

Heat to the hydrogen heater and octene vaporizer is supplied directly by means of hot fluid. The hydrogen and octene vapors are supplied to the converters at a temperature not above 200°C. (392°F.). Heat exchange is available and with a single-stage converter the one simple heat exchange is that between the converted gas stream and the octenes being fed to the vaporizer. Two heat exchanges are available in a countercurrent system, one on each converter.

Deterioration of equipment due to corrosion is negligible. Due to the low temperatures and pressures employed no special alloys or materials are necessary in the major pieces of equipment. No parts of the equipment suffer an abnormal rate of wear or deterioration.

Operation and control of the hydrogenation system are simple. The primary point of control is the unsaturation of the finished product as determined by titration with a weak brominating agent.

The use of catalyst guard tubes is advantageous for sulfur removal and catalyst conservation but normally the guard catalysts are not effective in promoting hydrogenation themselves. The total feed of hydrogen can be introduced into the octene vapors prior to passing through the guard tubes, but the large amount of hydrogen is not necessary in effecting sulfur removal. Therefore, the major portion of the feed hydrogen may be introdced following the guard tube, thereby increasing the contact time of a unit weight of octenes in the guard tube chamber. As a rough guide, one volume of guard catalyst is sufficient for two volumes of active catalyst.

Some plants include a catalyst tube for hydrogen feed to convert traces of carbon monoxide to methane and water and to eliminate possibility of nickel-carbonyl formation on cold spots in the catalyst bed. Usually this is not necessary, and the presence of water is not injurious to the active nickel catalyst. Normally, steam is used for purging the system of either air or hydrogen.

The foregoing brief description is based on a paper "The Catalytic Hydrogenation of Octenes to Octanes" contributed by the staffs of Shell Development Company and Shell Chemical Company, and presented before the American Petroleum Institute, Division of Refining, May 24, 1938, and the complete paper with detailed description of the process can be found in THE REFINER, Vol. 17, No. 6, June, 1938, page 283.

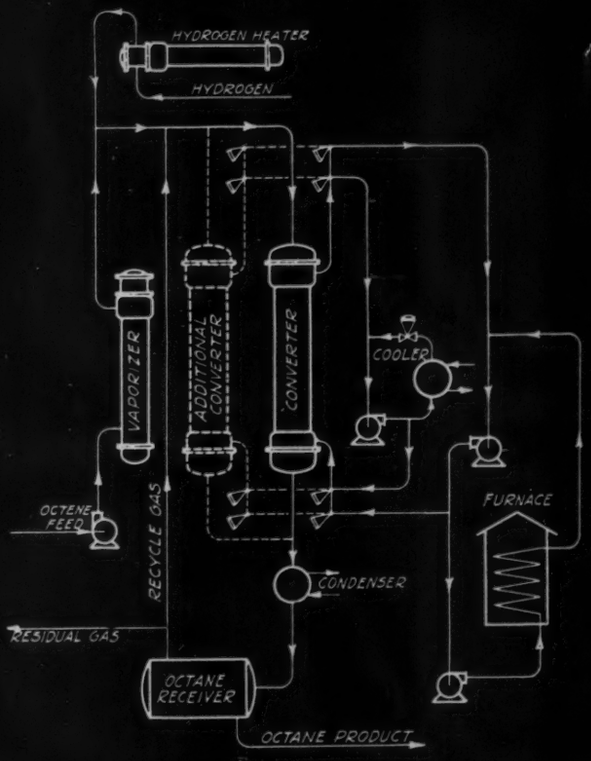


Figure 1—Single-Stage System

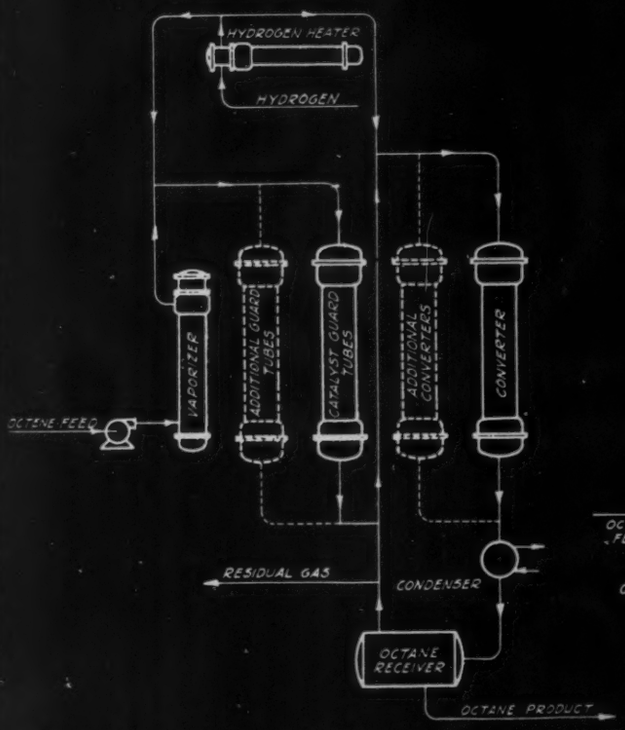


Figure 2—Single-Stage System with Catalyst Guard Tubes

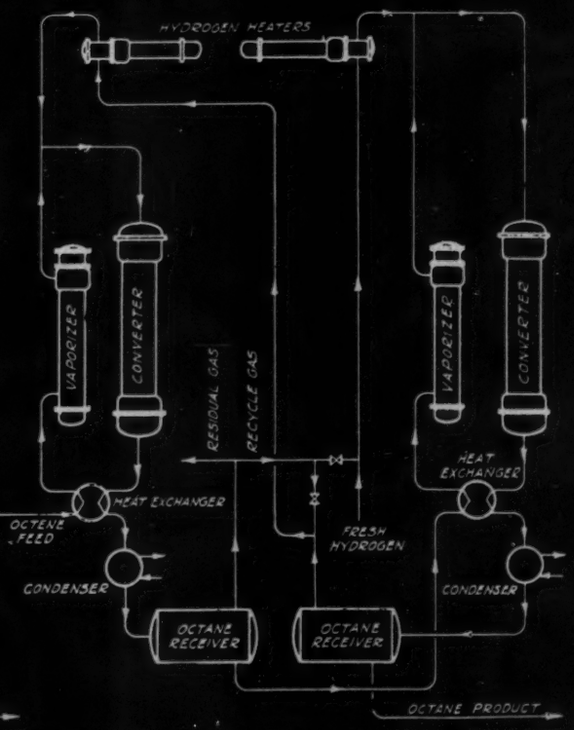


Figure 3—Two-Stage Countercurrent System

SHELL CATALYTIC HYDROGENATION PROCESS

Shell Catalytic Polymerization

BY SULFURIC ACID

THE Shell Companies have been producing *iso*octane from *iso*butylene in commercial scale for some time by two methods developed by them. The method uses hot sulfuric acid as a catalyst and a portion of the normal butylenes is polymerized along with the *iso*butylene. Almost double the yield of octenes is obtained from the same fuel stock and these, when hydrogenated, have an octane number nearly equivalent to that of pure *iso*octane. The feed stocks vary in different refineries but a C_4 fraction containing 18.5 percent isobutylene and 28 percent normal butylenes might be chosen as representative of that available at a California refinery.

The original development employed cold sulfuric acid and this processing unit is shown in Figure 1. It consists of an absorption section and a polymerization section. The liquid hydrocarbon is contacted with 60 to 70 percent sulfuric acid at 20 to 35° C. counter-currently in two stages. The absorption is an equilibrium reaction and the amount of *iso*butylene absorbed depends upon such controllable variables as acid strength, acid-to-alcohol ratio in the acid phase, and temperature. Under the proper operating conditions it is possible to absorb up to 90 percent of of the *iso*butylene without appreciably absorbing the normal butylenes. This cold-acid two-stage process has been in use for some time and it still is the most suitable method for preparing pure *iso*octane. However, on the basis of total olefins present the yield of octanes is relatively low; about 26.7 percent of the total olefins in a feed stock containing 46.5 percent olefins. Increasing demands for polymer of 98 to 100 octane number has led to the development of the present hot-acid process, in which almost twice the yield of octanes is secured from the same feed stock.

The hot-acid process, therefore, was a direct outgrowth of the former process. When the temperature of the acid absorption reaction is raised, the absorbed *iso*butylene present in the acid phase condenses to polymer and this is reabsorbed into the hydrocarbon phase. At temperatures above 60° C. this polymerization is sufficiently rapid that the absorbed *iso*butylene has only a transitory life in the acid phase, and the process is truly catalytic. The net effect is to force the absorption reaction to completion by maintaining the acid phase in a spent state. Thus it is possible to recover all of the *iso*butylene present.

Higher temperature also has the effect of reacting a portion of the normal butylenes and these are absorbed in the acid layer principally in the form of acid sulfates. While the normal butylenes do not polymerize with themselves as readily as does *iso*butylene, in the presence of *iso*butylene they will react rather rapidly to form interpolymer. Thus, under proper conditions, it is possible to react up to an equal quantity of normal butylenes and *iso*butylenes, and, as the interpolymer on hydrogenation has an octane number nearly equal to that of pure *iso*octane, nearly double the yield of polymer is obtained without seriously sacrificing octane rating. Hot-acid operation has the further advantage in that polymer as formed passes into the hydrocarbon phase and is diluted by the inert butanes; its activity is reduced, and there is less opportunity for trimer formation or re-arrangement to polymers of lower octane rating. The result is that the polymer is 95 to 90 percent octenes as against 75 to 80 percent for the former cold-acid process.

The flow chart of a typical hot-acid catalytic polymerization plant is shown in Figure 2. The reactor unit resembles a single stage of the cold-acid process. In fact the equipment is largely interchangeable. In the plant the fresh feed stock meets recycling emulsion, and the mixture is then rapidly recycled through a heat exchanger and time tanks. A portion of the emulsion is continuously withdrawn to a separator, where the acid is separated and returned to the reactor, while the hydrocarbon is worked up for the polymer.

The operation of the unit is simple; one operator per shift being sufficient. No external heat is required, as the exothermic heat of reaction is sufficient to maintain the temperature in the reactor. Return of acid to the reactor is largely automatic, once the rate of flow is established. Present practice is to use 67 percent acid at approximately 80° C. and a 10 to 15 minute average contact time is allowed.

The polymer in the hot-acid system is recovered from the hydrocarbon layer. Recovery consists of a caustic wash to remove entrained acids or acid sulfates; a flash tower to strip off spent hydrocarbon gases, and high temperature treater for further sulfur removal. The polymer is rendered stable to distillation or it can be added directly to gasoline without impairing color or stability. The octene fraction is refractionated and hydrogenated under mild conditions. The product obtained averages 98 to 99 octane number. Thus, as previously stated, by hot-acid operation the yield has been doubled without sacrifice of octane number.

The foregoing brief described is based on a paper "The Catalytic Polymerization of Butylenes by Sulfuric Acid," by S. H. McAllister, Shell Development Company, presented before the American Petroleum Institute, Division of Refining, November 12, 1937, and the complete paper with detailed description of the process can be found in The Refiner, Vol. 16, No. 11, November, 1937, page 493.

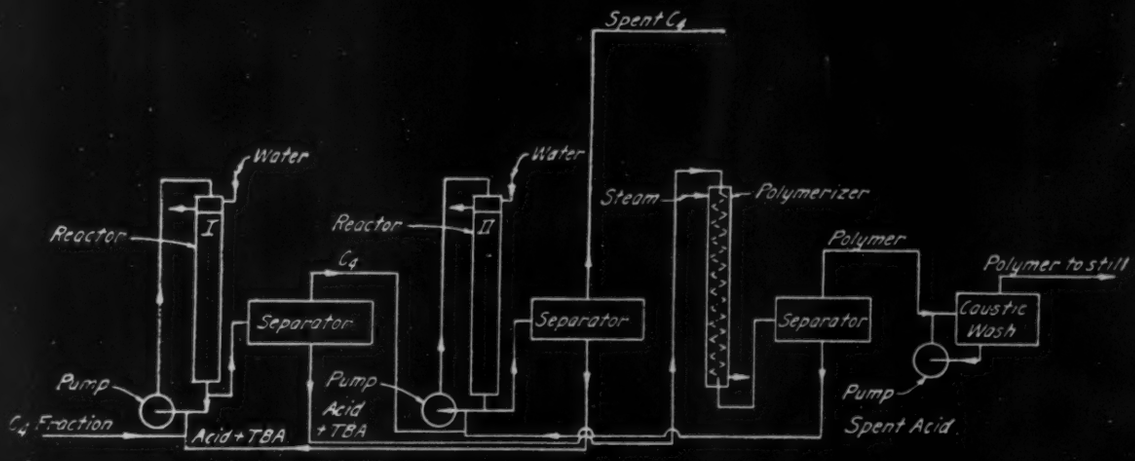


Figure 1—Cold-Acid Isooctane Plant

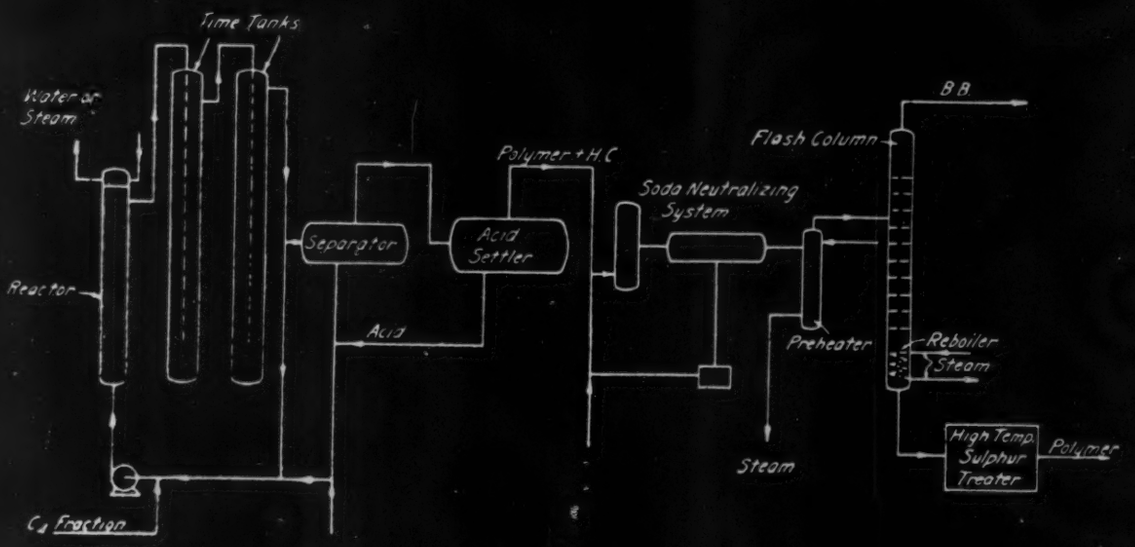


Figure 2—Hot-Acid Polymerization Plant

SHELL CATALYTIC POLYMERIZATION PROCESS

Thermal Polymerization Process

THE thermal polymerization process of the Polymerization Process Corporation may be used for the production of motor fuels from either natural or refinery gases. It is a unitary non-catalytic process which converts both saturated and unsaturated hydrocarbons, assuring a maximum yield of high octane blending value gasoline. The process has been proven by actual commercial application; individual and co-operative research and pilot plant operation provide a background for the prediction of yields from gases of varying composition. The joint experience and engineering knowledge of a group of refiners and engineers is represented in the design of thermal polymerization plants of the aforesaid licensor corporation.

Gaseous hydrocarbons normally produced from the refining or production of petroleum comprise essentially the following: Hydrogen, Methane, Ethane, Ethylene, Propane, Propylene, Butane, Butylene.

Natural gases consist essentially of saturated hydrocarbons, and thermal polymerization represents a method of processing this material to super-grade blending fuel. Under certain conditions, the supposed chemical inertness of saturated hydrocarbons may be overcome and they may be made to act directly. By the proper choice of temperature and pressure, polymerization and cracking of gas components may be effected simultaneously, the control being such as to produce a liquid product.

When either refinery or field gases are charged to a thermal polymerization plant, the hydrogen, methane and a portion of ethane in the fresh feed and polymerization coil gas are separated from the higher molecular weight components and discharged as residue gas. Feed to the high temperature polymerizer coil may have a composition varying from propane or butane alone or any proportions of these, to a complex mixture of C_2, C_3 and C_4 compounds in which unsaturates amount from zero to as high as eighty percent.

Yields are obtained which approach the ultimate by recycling a portion of the C_2 and the major portions of the C_3 and C_4 components leaving the polymerization coil. Temperature and pressure conditions in the polymerization zone range from 950° to 1100°F. and from 1000 lbs. to 3000 lbs. per square inch, respectively, depending upon feed analysis. No catalysts are used and therefore none of the accompanying problems of catalyst handling and revivifying are present.

Polymerization products comprise fuel gas (residue) containing the lighter hydrocarbons, polymerization gasoline, and a very small quantity of light oil boiling above the gasoline range. Liquid yields of over 14 gallons (net) per 1000 cubic feet of gaseous feed may be obtained. Polymerized gasoline has characteristics which display the following qualities:

(a) The boiling range exhibits excellent volatility.

(b) It is a stable product highly saturated in nature.

(c) It is not gum forming, and may be readily refined with light treatments of clay contact or acid.

(d) The octane value is extremely high.

A typical inspection of this distillate follows:

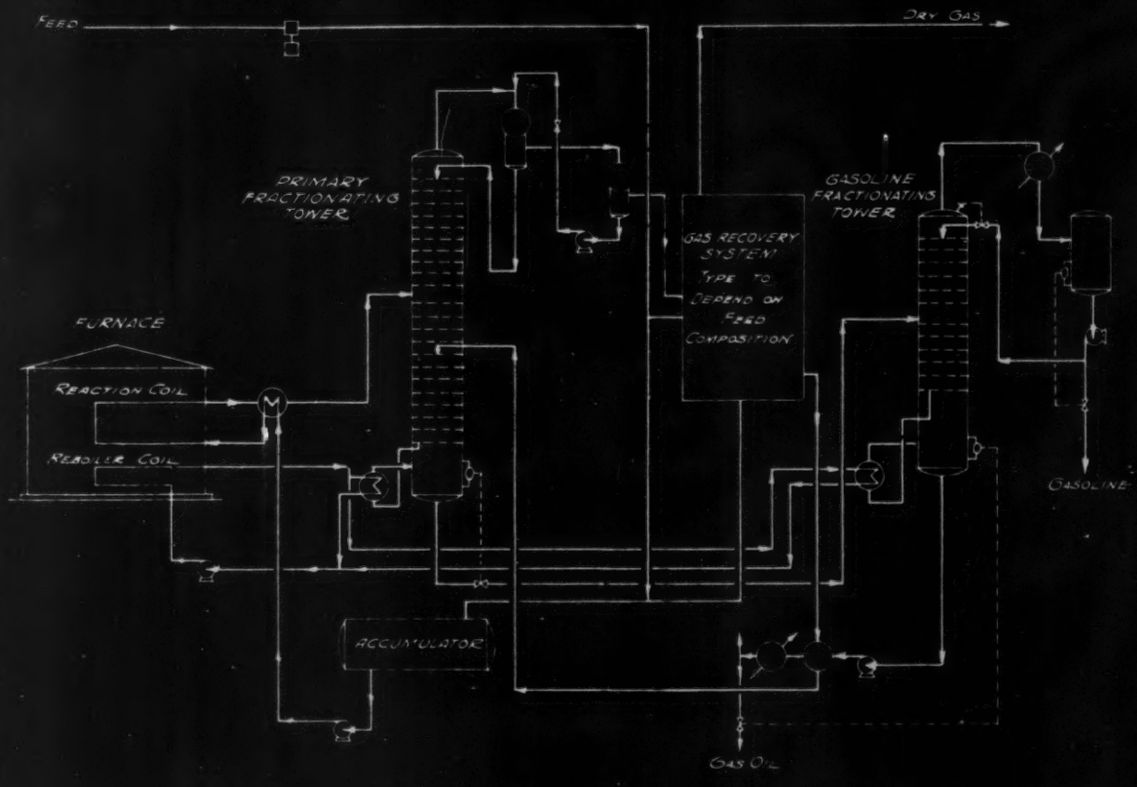
A.P.I. Gravity	60 to 64°
Initial Boiling Point	94°F.
20%	140°F.
50%	170°F.
90%	330°F.
End Point	400°F.
Octane, CFRM—Clear	77-78
Octane blending value with respect to Ref. Fuel "A"	80 to over 100
Saturation (Acid Absorption)	80 to 86% insoluble

The accompanying flow sheet is representative of the process design of thermal polymerization plants. The polymerization unit proper consists of a heating coil and fractionators for separating the liquid furnace feed and for separating the gasoline product and polymer gas oil. The reaction coil surface may vary with the feed composition, otherwise the polymerization systems are comparable. The exact type of gas and cycle stock recovery system is dependent on feed compositions and local refinery conditions, therefore no attempt has been made to outline on the flow sheet any one of the several types of absorption, condensing or rectifying methods that could be used.

A polymerization plant is comparable in simplicity to the usual cracking and stabilization unit. However, gas volumes and properties are dependent upon pressure and temperature; therefore, the features of the gas supply and the refinery must be given recognition in designing a polymerization plant for any specific location. Types and sizes of auxiliaries are chosen in accordance with the characteristics and relative values of utilities. Thus, each application of thermal polymerization requires a refinery field study. Investment cost of one of these units varies with conditions local to the site of installation. The operating or running expense of thermal polymerization plants is low even in localities of high utility rates. The fact is that thermal polymerization gasoline is made at a cost which favorably compares with the cost of producing motor fuel by any other refining method. Because of high octane blending value and low volatility, the usual polymerization gasoline is worth more than other refinery gasolines.

Large commercial installations of this process have been in operation at the Phillips Petroleum Company's Borger, Texas, refinery for several years. Three more recent installations, designed and constructed by The M. W. Kellogg Co., were placed in operation during 1937 for two of the major refiners.

The M. W. Kellogg Company, 225 Broadway, New York, N. Y., has been appointed licensing agent for the Polymerization Process Corporation for the United States and foreign counties. Licenses granted will be under the Polymerization patents and patent rights of the Phillips Petroleum Company, Standard Oil Company (Indiana), Standard Oil Company (New Jersey), The Texas Company, and The M. W. Kellogg Company.



THERMAL POLYMERIZATION PROCESS

COURTESY, THE M. W. KELLOGG COMPANY

Catalytic Polymerization Process

THE U.O.P catalytic polymerization process produces a new kind of gasoline from the gases that are a by-product of cracking operations. This material is presented here through the cooperation of Universal Oil Products Company, Chicago. Illinois.

In the process the cracked gases are preheated and passed through towers which contain a solid, phosphoric acid catalyst. Moderate temperature and pressure conditions are maintained in the towers.

A typical flow chart of the process is shown on the opposite page together with a photograph of a commercial U.O.P. polymerization plant which is daily processing 15,000,000 cubic feet of gas and producing about five gallons of polymer gasoline per 1000 cubic feet.

The yield of polymer gasoline depends on the percentage of heavy olefinic gases, such as propene and butenes, in the cracked gas processed. As an example, the average yield of this type of gasoline when processing Dubbs cracked gas is from three to six gallons per 1000 cubic feet. However, where the olefinic content of the gas treated is higher, proportionately higher yields of polymer products are obtained.

The polymer gasoline has a clear octane number of about 81, but it has a value up to 125 when blended with other gasoline, depending upon the percentage and the gasoline with which it is blended. This may be considerably higher than the blending value of pure benzol or iso-octane, both of which, alone, have higher octane numbers than polymer gasoline.

It is chiefly this peculiar high-blending power which makes U.O.P. polymer gasoline so valuable an addition to the refiners' operations.

The U.O.P. catalytic polymerization process can do four important things for the refiner: (1) Increase gasoline production by 2 to 5 percent without increased crude supply. (2) By blending his output of polymer gasoline with part of his Dubbs cracked gasoline, he can produce a fuel of premium octane rating, which has a high merchandising and advertising as well as service value. (3) By blending his polymer gasoline with all his Dubbs cracked gasoline, the endpoint of his gasoline can be raised 15° to 25° F., without decreasing the overall octane number. This means increasing his gasoline yield by about 2 percent and increasing the capacity of his Dubbs units by 10 to 15 percent. (4) If "Q" gasoline is sold the refiner can cut his lead bill by reason of the high blending value of his polymer gasoline.

Since polymerization is the combination of olefins to form larger molecules it is apparent that saturated substances (paraffins) do not yield polymers. On the other hand, saturated hydrocarbons may be catalytically dehydrogenated or cracked to olefins. Thus, in order to produce gasoline from normally gaseous olefins, one reaction takes place—polymerization. In order to produce gasoline from normally gaseous paraffins, two reactions take place—one a cracking or dehydrogenation, the other polymerization. It should be pointed out that to produce olefins from paraffins, high temperature must be used, while polymerization of olefins is favored by low temperatures. To crack paraffin gases and polymerize the olefins formed calls for opposing reactions, and therefore the conditions best suited for olefin formation are not suitable for the polymerization reaction. From a theoretical and practical standpoint it is best to produce the olefin gases under optimum cracking or dehydrogenating conditions and then convert the olefins to liquids under the conditions most suitable for their polymerization. The catalyst employed in the U.O.P. catalytic polymerization process has a long life, it is not impaired by hydrogen sulfide and can be regenerated in place by a simple air-burning operation at infrequent intervals when this is necessary. The equipment designed for U.O.P. catalytic polymerization is simple and relatively inexpensive to build and operate.

The installation shown in the photograph has been in successful operation for more than a year in the plant of a large refining company. Many other companies have installed or are installing the process.

A further development of catalytic polymerization is the U.O.P. iso-octane process which produces motor fuel of 96 octane number, which makes it possible practically to double the speed of airplanes.

There are 23 U.O.P. catalytic polymerization plants of all types now in operation or under construction.

UNIVERSAL OIL PRODUCTS CO.
CATALYTIC POLYMERIZATION PROCESS
COURTESY, UNIVERSAL OIL PRODUCTS COMPANY
UNIVERSAL OIL PRODUCTS CO.
CATALYTIC POLYMERIZATION PROCESS
CONDENSER
STABILIZER
COLUMN
RICH GAS
HEAT EXCHANGER
STEAM EXHAUST
REBOILER
STEAM
COOLER
STABILIZED POLYMER TO STORAGE
LEAN GAS
RECEIVER
CONDENSER
CATALYST TOWERS
TO STACK WHEN REACTIVATING
FUEL GAS
REACTIVATING LINE
HEATER
WATER PUMP
GAS COMPRESSOR
POLYMER GASOLINE 880 GALS/HR
WATER 22500 GALS/HR
STEAM 1800 LBS/HR
POWER 5 K.W./HR
FUEL 2000000 B.T.U./HR
GAS POLYMERIZED 28000 CU.FT./HR
LABOR 1 MAN/HR

U. O. P. *Iso*octane Process

A COMMERCIAL plant is described which treats butane-butene mixtures selectively to polymerize the normal and *iso*butenes contained therein, having a daily capacity of 1300 barrels of butane-butene fraction, from which is produced 347 barrels of *iso*octenes. These *iso*octenes are catalytically hydrogenated to *iso*octanes, the latter having octane ratings of from 90 to about 100—dependent upon the conditions under which they are produced.

The catalytic production of *iso*octenes from the normal and *iso*octene present in cracked gases is being carried out commercially under relatively mild conditions. The *iso*octanes produced are hydrogenated into *iso*octanes with values ranging as stated above. These octane ratings can be controlled as a function of the percentage of normal and *iso*butene present in the charge and of the time, temperature, and pressure conditions. The higher the octane rating, the lower the yield of *iso*octanes per barrel of the butane-butene processed.

The process of producing *iso*octanes by the catalytic polymerization reaction (U.O.P. Catalytic Polymerization Process), uses as a charging stock the butane-butene (BB) fraction from the stabilizer producing the vapor pressure cracked gasoline desired. The BB fraction contains 15 percent of *iso*butene, 30 percent of normal butene, and 55 percent of normal and *iso*butanes. A flow chart of the *Iso*octane Process is shown on the opposite page.

The butane-butene charge is passed through a caustic-soda scrubber to remove the sulfur components present. The liquefied hydrocarbon gas is then pumped through a heating coil, wherein the temperature is raised to about 350°F. under a pressure of about 600 pounds. The BB fraction then passes through a "solid phosphoric-acid" catalyst, wherein the exothermic heat of the reaction is controlled by a cooling fluid, such as oil around the reaction tubes, and the desired temperature is maintained during the polymerization. Dependent upon the time-temperature conditions prevailing and the percentage of normal to *iso*butane present in the charge their combination takes place in varying proportions.

The polymer product is then passed to a tower, where it is stabilized—after which it is fractionated into the *iso*octenes (dimers) and the dodecenes (trimers). In general the percentages of *iso*octenes in the polymer product is about 85 percent the balance being trimers. The polymer product produced is 30 percent of the butanes-butenes fraction charged to the unit. This is when producing *iso*octenes (85 octane) on the basis of a charge of 1:1 ratio of normal *iso*butene. The *iso*octene fraction which boils between 200 and 260°F. is hydrogenated to *iso*octanes of 96 octane rating. The commercial unit described processes 1300 barrels of the butane-butene fraction, producing 347 barrels of *iso*octenes and 43 barrels of trimers. The *iso*octenes are converted into *iso*octanes by catalytic hydrogenation.

The *iso*octanes being produced commercially have a boiling range of 200 to 260°F. and, therefore are not a complete motor fuel as to volatility. They require blending with hydrocarbons such as those of the aviation-gasoline boiling range or *iso*pentane, or *iso*hexanes, in order to give volatility to the fuel.

In some cases *iso*pentane is blending with *iso*octane and straight run gasoline to provide required front-end volatility to the *iso*octane. The volume of *iso*pentane is generally restricted to about 15 percent. The results of blending 100 *iso*octane fuel, 74 octane aviation straight run of 7 pounds Reid vapor pressure, and *iso*pentane with 3 cc. of tetraethyl lead to produce 100 octane fuel are shown in Table 1.

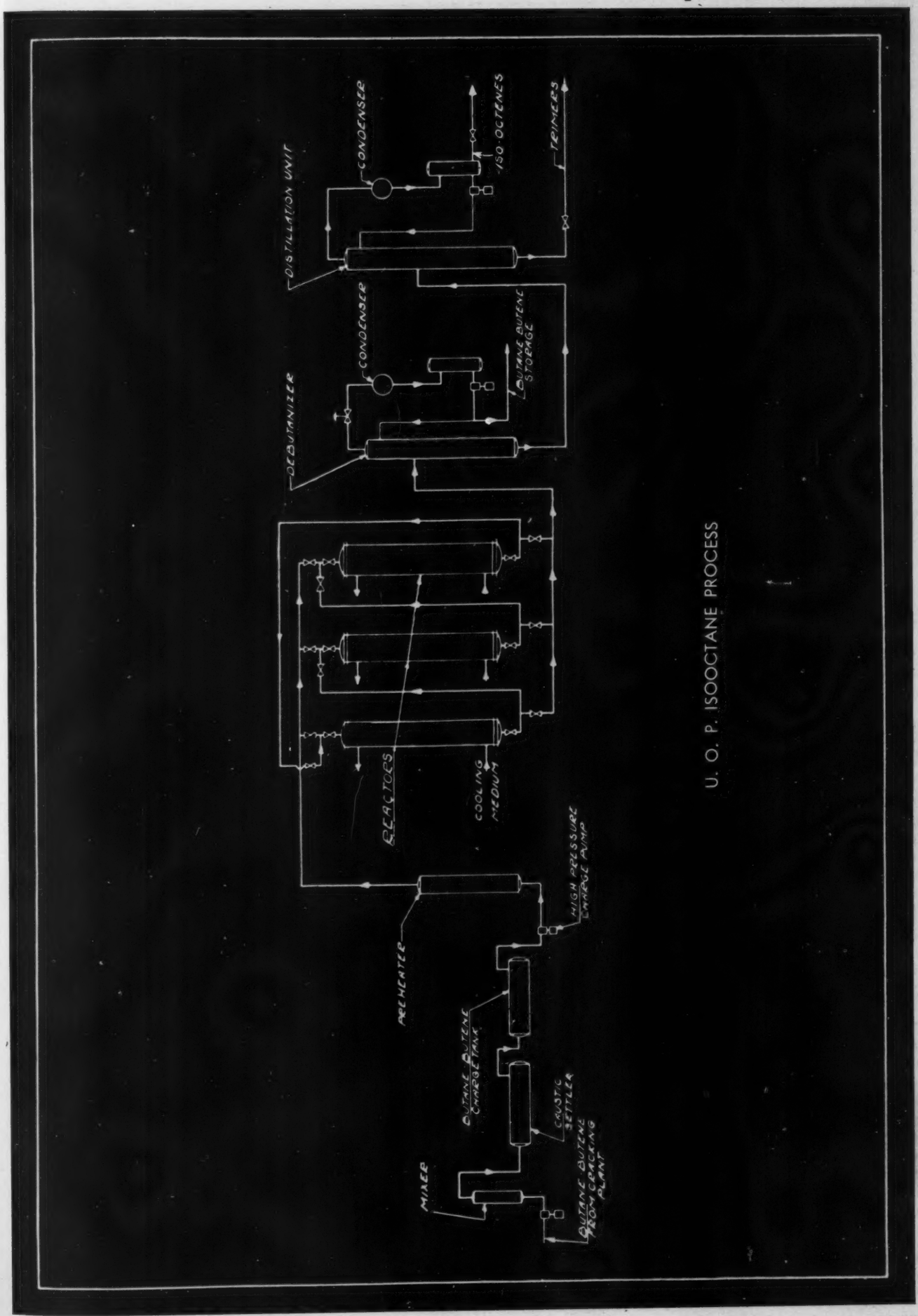
TABLE 1

Composition of 100-Octane Fuel Containing 3 cc. Tetraethyl Lead Per Gallon

*Iso*pentane (Percent)	Aviation Gasoline (Percent)	*Iso*octane (Percent)	Reid Vapor Pressure (Lb. Per Sq. In. at 100° F.)
0	38.0	62.0	4.0
10	37.2	52.8	5.8
17	36.7	46.3	7.0
20	36.4	43.6	7.7
30	35.7	34.3	9.5
40	34.9	25.1	11.4
50	34.1	15.9	13.3

The importance of *iso*octane in aviation fuel has been established for special uses such as military aviation and high-revenue transport. It may be readily predicted that within a short time all passenger planes will be operated with motor fuel of 100 octane or higher. The dominant position of polymerization in the economy of motor fuel production is also definitely established in that small amounts of polymer gasoline may be used to correct an octane deficiency in the gasoline production of the refinery, and thus function to balance the quality of motor fuel produced.

The foregoing is based on a paper "Motor Fuels from Polymerization," by Gustav Egloff, J. C. Morrell and Edwin C. Nelson, Universal Oil Products Company, which was presented before the American Petroleum Institute, Division of Refining, November 11, 1937, and presented in full in THE REFINER, Vol. 16, No. 11, November, 1937, page 497. The complete paper describes three modifications of the polymerization process: a, polymerization of hydrocarbon gases containing propene and butene; b, pyrolytic cracking of butanes (and also propane) to produce olefin hydrocarbons followed by catalytic polymerization to produce polymer gasoline; c, selective polymerization of normal and *iso*butene and hydrogenation of the resulting octanes into *iso*octanes, this latter process being chiefly described above.


U. O. P. ISOOCTANE PROCESS
DISTILLATION UNIT
CONDENSER
ISO-OCTENES
TRIMERS
DEBUTANIZER
CONDENSER
BUTANE BUTENE STORAGE
REACTORS
COOLING MEDIUM
HIGH PRESSURE CHARGE PUMP
PRE-HEATER
BUTANE BUTENE CHARGE TANK
CAUSTIC SETTLER
MIXER
BUTANE BUTENE FROM CRACKING PLANT

Continuous Contact Filtration

CONTACT filtration is a universally known process wherein petroleum lubricating oils are rapidly and efficiently refined by the simple procedure of mixing oil directly with a fine bleaching clay, heating for a short period and then separating the decolorized oil from the spent clay.

The superiority of this process over other methods of refining has been greatly increased by recent improvements in equipment design and in bleaching clays, which in turn has simplified the operation, improved product quality and lowered costs. Some of the major advantages which are now recognized are briefly summarized below:

1.—Continuity of Operation. The contact process as now developed permits continuous operation from start to finish. This advance has been largely accomplished as a result of recent improvements in equipment manufacture.

2.—Large Throughput with Minimum Space and Equipment Requirements. Inasmuch as this process provides ready adjustment of contacting temperature it is obviously possible to handle stocks of a wide viscosity range with but little effect on plant throughput. The cost of modern contact plant installations are relatively low; for example, a 500-barrel a day plant can be installed for approximately $70,000. Such a plant will occupy a space not greater than 80 feet wide by 120 feet long.

3.—Ease of Switching from one Type Stock to Another. Due to the flexibility of the contact equipment and its small volume changes from one type oil to another can be effected with minimum time loss.

4.—Low Labor Cost. A modern thousand barrel a day contact plant can be operated with but two men per shift. Equipment design has undergone improvement to the extent that substantially each unit of the plant can be controlled automatically.

5.—Rapid and Accurate Cost Analysis. Contrary to other refining processes wherein one must arrive at costs on the basis of intricate operations covering considerable periods of time, the simplicity of the contact process makes it possible to obtain accurate daily cost data. Thus the management is constantly provided with true costs of the finished oils, either individually or collectively.

6.—High Overall Yields. Using .4 lb. clay per gallon on a typical lubricating stock the contacting yield of filtered oil approximates 97 percent. If absorbent oil is recovered from the spent clay by naphtha washing, the yield may be increased to approximately 99 percent. This figure does not include overhead stripping losses which in general do not exceed 1 percent.

7.—High Quality Products. Uniform and predictable color, superior casts, lower carbon residues, improved emulsion and oxidation tests and increased viscosity index, are among the outstanding merits of this process. The use of fresh and uniformly standardized clay on contact processed oils eliminates the uncertainties sometimes found with other methods.

8.—Adaptability to Other Refinery Processes. A contact plant can be used to clarify, decolorize, and/or neutralize lubricating oils whether they have been acid-treated, solvent extracted or simply distilled. In addition to finishing the normal production of such processes, the contact plant is often used to instantly correct previous faulty refining. Sour oils are neutralized and decolorized in one operation, eliminating caustic neutralization and the accompanying disadvantages of emulsion formation and poor casts.

9.—Low Operating Costs. Costs of contacting are generally low, ranging from less than four-tenths of a cent per gallon for light service to somewhat over three cents per gallon where duty is heavy such as in the case of dark cylinder stock.

10.—Maximum Clay Economy. Modern equipment and bleaching materials permit operation of the contact process at higher temperatures than formerly, due to provision for effective heating and stripping of the clay-oil mix in minimum time. Generally speaking, clay efficiencies increase with temperatures, the optimum point being at or near the flash point of the contact oil.

On the opposite page is a flow diagram of a continuous contact plant presented through the courtesy of Filtrol Corporation, 315 West 5th Street, Los Angeles, Calif. After clay has been added by means of automatic proportioning equipment to the oil charge, the oil-clay mixture then enters a pipe still heater where the maximum contact temperature is obtained in a once-through operation. From the heater, the oil-clay slurry enters a baffled vacuum stripping tower where a level is maintained regulating the time of contact. Steam is sometimes passed up the tower to facilitate the stripping action. The slurry is drawn continuously from the bottom of the tower, passed through the heat exchanger utilized to heat the fresh oil charge, and thence to a filter surge tank which acts as a reservoir to feed the continuous precoat rotary filter. This filter removes all traces of clay from the oil which may then be pumped to finished storage. In a few cases where the conditions warrant it, the spent filter cake is extracted with naphtha to recover the small additional quantity of oil soakage.

In the case of heavy oil fractions containing wax, the oil may be put through the process twice with dewaxing taking place between the two contacts. Clay addition, temperatures, rates, etc., are all subject to automatic control in modern installations, hence long uniform runs are currently made without difficulty.

FILTROL FRACTIONATION

Just as crude distillation and cracking processes have been combined into single units, so Filtrol Fractionation brings together the former separate processes of fractional distillation of lubricating oils and the decolorization finishing operation. As in all combinations, a considerable initial saving is made in equipment costs and a saving in operating. In this instance, a separate contact heater is eliminated inasmuch as the primary crude or rerun distillation unit takes its place.

Essentially the equipment is the same as in Continuous Contact Filtration (see opposite flow sheet) up to the point where the oil-clay slurry enters the stripper. In place of the contact stripper the usual fractionating tower is operated to obtain desired overhead lubricating cuts of definite predetermined specifications.

The bottoms and clay collect in the lower part of the tower where a level is maintained to allow the full charge of the clay to act on the most difficultly decolorized but reduced portion of the oil. The oil-clay slurry from the bottom is then handled in the same manner as in the contact filtration process.

It has been found that no special precautions are necessary because of the addition of Filtrol to what is otherwise a normal fractionation process. Contrary to what might be expected, no clay carries over into the side-streams, nor is it found to collect on the bubble caps or plates. The tower may be designed to operate at atmospheric pressure or with vacuum. The injection of steam is usually practiced at the base of the tower as well as in the tube still heater. Since the clay is separated from all vaporized fractions a small filtering capacity is required.

This process is primarily designed for use on lube bearing crudes, solvent treated stock, acid treated long residuals, dewaxed bright stock solutions and pressed oils.

Continuous contact filtration is licensed through Filtrol Corporation and plans are now under way to make Filtrol Fractionation also available through Filtrol Corporation.

FRESH OIL CHARGE
FINISHED OIL
SPENT CLAY
CONTINUOUS ROTARY FILTER
SURGE TANK
HEAT EXCHANGER
VACUUM STRIPPER
PIPE STILL HEATER
VACUUM
LEVEL CONTROL
STEAM
CLAY
SCALE
MIXER
TYPICAL CONTACT FILTRATION PLANT
CONTINUOUS CONTACT FILTRATION PROCESS
TYPICAL FILTROL FRACTIONATION PLANT
COURTESY, FILTROL CORPORATION

Percolation Filtration Process

THE percolation filtration process for the purification of petroleum fractions has long been used by refiners to produce lubricants, distillates, waxes and specialty products of desired color, stability, emulsion test, sludging characteristics, odor, and taste. In recent years, the application of technical control and improvements in equipment, coupled with the introduction of improved adsorbent materials, have resulted in decreased costs and increased processing efficiency.

Percolation filtration comprises essentially the filtering of a partially refined petroleum fraction through a granular bed of adsorbent material. The oil is thus exposed, in counter-current fashion, to large quantities of fresh adsorbent which, when spent, may be washed with naphtha, steamed, and revivified by burning in rotary or multiple hearth furnaces.

Lubricating oil stocks may be refined by this process, by percolation either as viscosity oil or in dilution with 50 percent or more of naphtha. The decolorization of a residual stock in naphtha solution is shown in the flow chart presented on the opposite page, through courtesy of the Attapulgus Clay Company, 260 South Broad Street, Philadelphia, Pennsylvania. It will, of course, be realized that individual cases will require special consideration.

Adsorbents commonly used in the percolation process are fullers earth and bauxite, although small amounts of bone black and similar products are occasionally utilized in the production of certain waxes and specialties.

In recent years considerable improvement has been made in the adsorptive power of fullers earth which is an alumino-silicate occurring chiefly in the Georgia-Florida region. Fullers earth is normally received by the refiner in granular form, usually 30/60 mesh, following which it is burned at a temperature of 800-900° F. and charged to the percolation filters which vary in capacity from 10 to 50 tons. The filter is then filled with oil and permitted to soak, following which percolation ensues to the desired finished color. The filter is then drained, washed with naphtha, steamed until not more than 1 percent of oil remains in the clay, dumped, and revivified, preferably by indirect firing methods, at a maximum clay temperature of 1100° F.

The use of fullers earth in percolation filtration gradually decreases the efficiency of the clay to a point where it is discarded and replaced with fresh earth. The proper point of clay discard varies with the type of stock to which the earth is applied, and is readily determined by simple cost calculations.

Percolation operation utilizing bauxite as the adsorbent deviates in several significant respects from fullers earth filtration, since the adsorptive power of bauxite has been found to vary considerably with the type of stock filtered, the finished oil color desired, the burning temperature used, and the temperature at which filtration is effected. For example, in the solution percolation of residual stocks to dark finished oil colors increase in the burning temperature to 1600° F. results in progressively increased decolorizing efficiency. Greater efficiency is also obtained by percolation at the maximum practicable temperature. Conversely, in the percolation of light colored distillate stocks maximum efficiency is obtained by operation at the minimum practicable temperatures of burning and filtration.

Owing to the variable adsorptive properties of bauxite, therefore, the selection of adsorbent for a given decolorization problem depends upon a detailed investigation of the particular stock to be refined. In general, bauxite may be said to possess the advantageous qualities of revivification without substantial degradation in efficiency, thereby eliminating the disposal of spent adsorbent and increasing filter house capacity; together with a high decolorizing and deodorizing value for such light colored stocks as waxes and petrolatums. On the other hand fullers earth operation is generally less complex and is characterized by more satisfactory filter washing, and, in general, lower maintenance and repair costs.

Regardless of the adsorbent employed, the percolation filtration process possesses certain inherent merits which should be borne in mind in considering the, intallation of decolorizing facilities.

(1) It is essentially a low cost process, the greater part of the manufacturing cost comprising expense other than adsorbent cost. For this reason improvements in operating procedures are reflected in reduced decolorization costs to a much greater degree than other processes in which the adsorbent cost constitutes the major item of expense.

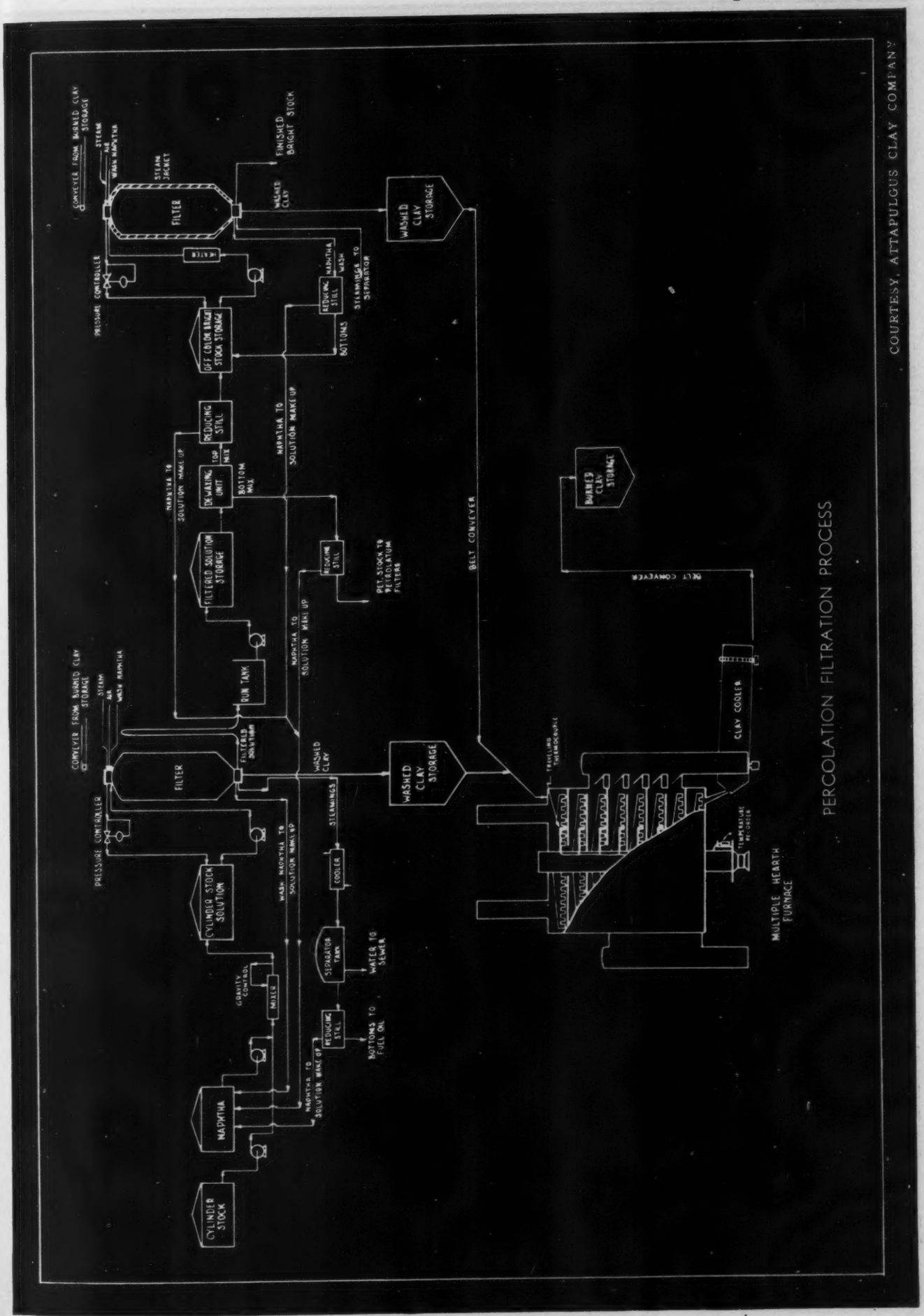
(2) It is essentially a counter-current process in contrast to other decolorization methods which frequently represent the least desirable application conceivable from the standpoint of counter-current operation.

(3) It is flexible, permitting simultaneous processing of several products in the filter house as well as production of several "specialty cuts" from the same filter.

(4) It is an adsorption process operating at low temperatures, and, as a result, yields finished oil of generally higher quality than other decolorizing procedures which expose the oil to advanced temperatures in the presence of highly active catalytic material.

(5) Installation costs, contrary to popular opinion, are in line with competing processes, when designed to handle similar loads.

(6) Ultimate yields, that is, yield of decolorized oil in percent of stock charged, are generally higher than those characteristic of other decolorization processes.


PERCOLATION FILTRATION PROCESS
COURTESY, ATTAPULGUS CLAY COMPANY
CONVEYER FROM BURNED CLAY STORAGE
STEAM
AIR
WASH NAPHTHA
FILTER
STEAM JACKET
FINISHED BRIGHT STOCK
WASHED CLAY
WASHED CLAY STORAGE
PRESSURE CONTROLLER
WATER
OFF COLOR BRIGHT STOCK STORAGE
REDUCING STILL
NAPHTHA WASH
STEAMINGS TO SEPARATOR
BOTTOMS
NAPHTHA TO SOLUTION MAKE UP
DEWAXING UNIT
TOP MIX
BOTTOM MIX
FILTERED SOLUTION STORAGE
REDUCING STILL
PET. STOCK TO PETROLATUM FILTERS
BELT CONVEYER
BURNED CLAY STORAGE
RUN TANK
FILTERED SOLUTION
WASHED CLAY
STEAMINGS
COOLER
CLAY COOLER
TRAVELING THERMOCOUPLE
WASH NAPHTHA TO SOLUTION MAKE UP
CYLINDER STOCK SOLUTION
SEPARATOR TANK
WATER TO SEWER
GRAVITY CONTROL
MIXER
REDUCING STILL
BOTTOMS TO FUEL OIL
NAPHTHA TO SOLUTION MAKE UP
NAPHTHA
CYLINDER STOCK
MULTIPLE HEARTH FURNACE

X-YTE Percolation Filtration Process

THE X-YTE Percolation Filtration Process as developed by Max B. Miller & Company, Inc., 501 Fifth Avenue, New York, N. Y., maintains all the merits of the standard percolation filtration process and in addition contributes many features which may be traced directly to the absorbent X-YTE.

X-YTE is a product resulting from the calcining, the activation, and sizing of a very select portion of the high alumina ore Bauxite. It is only recently that extensive tests have (a) located a supply of select ore suitable for the production of a unique product, (b) have established in the laboratory a technique for preparing and applying the product, (c) have perfected the final details of the process in a commercial installation in an oil refinery.

Since the X-YTE filtration process does not deviate from the major principles of the long standing standard percolation filtration process, any existing plant may use X-YTE without change except that arrangement must be made by which temperatures from 1200° F. to 1400° F. may be developed for reburning.

When X-YTE is used in connection with the filtering of neutrals, it may be reburned at a temperature of 1200° F. Use with heavy residual oils, however, requires a reburning temperature of 1400° F. to retain maximum efficiency. The physical and mechanical properties of this absorbent are such that temperatures of 1400° F. do not destroy its effectiveness. The clay may be burned in multiple hearth clay burners or even in rotary kilns. Since higher temperatures are required, less excess air is employed in firing, with the result that gas velocity is decreased and higher charging rates may be maintained. X-YTE may be reburned and reused until destroyed through dust loss. Every indication points to a dust loss of not over 1 percent per cycle with careful operation. Less exacting handling points to dust losses of no more than 2 percent. Using the conservative figure, it can be seen that the life of X-YTE is equivalent to being reburned and reused fifty times.

It has been proven that throughout its life with proper handling X-YTE retains its decolorizing efficiency of from 80 percent to 90 percent of the original material. Snow white and amber petrolatum filtered through X-YTE are odorless and tasteless, regardless of the number of times that the X-YTE has been reburned. Since X-YTE retains its efficiency on reburning, it is neither necessary nor desirable to segregate the material from the different burns. This is effective in greatly reducing storage and inventory of green and burned filtering material and greatly simplifies the handling to and from the filters.

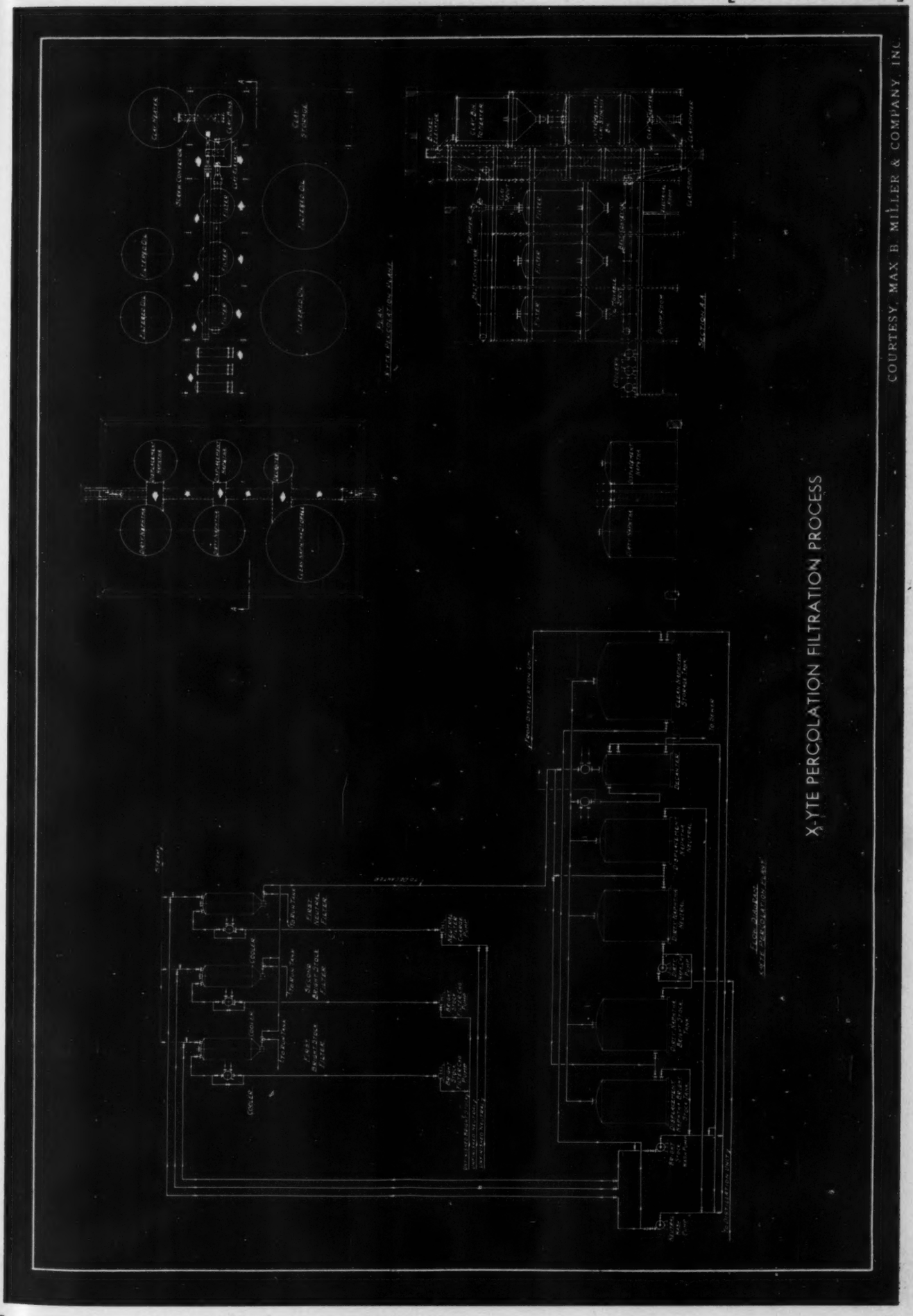
In those periods in which it has been desirable to produce the maximum amount of finished lubricating oil, the filtering plant has in many refineries proved to be the "neck of the bottle." One of the most interesting features of X-YTE comes from the fact that it will increase the yield of a given filter. Burned X-YTE is as efficient per ton as the average burned Fuller's Earth, and it is denser—weighing from 1.7 to 2.0 times as much as Fuller's Earth. In consequence, more tons can be gotten into a given filter accounting for a corresponding increase in yield. Comparative tests have shown that the yield of a given filter is 70 percent greater with X-YTE than it was in the case of Fuller's Earth.

It cannot be said, however, that the increased yield per filter derived from the use of X-YTE truly represents a net increase in the capacity of a single filter or a filter plant as a whole. A major portion of the filtering cycle is used up in charging, filter soaking time, steaming, washing, etc., and is about the same for either medium. On the total filter cycle the effective increase in filter yield with X-YTE will be less than the 70 percent mentioned. Comparative tests have again shown the advantage of X-YTE to be 40 percent increase in filter yield on the total cycle.

In the flow sheet attached three filters are provided, all the same size, having ample capacity for 15 tons of X-YTE charge. Two filters are utilized on bright stock and one on neutrals. The total filter cycle will be approximately twice as long on the neutral as for the bright stock. Provisions are made for either heating or cooling the filter charge stocks, as may be necessary, in order to maintain a constant filtering temperature. In new installations filters would be provided with a hot air jacket and the heating medium would be the hot air discharge from the cooling air for the furnace shaft and rabble arms.

After completion of the filtering cycle the stock retained in the filters is recovered by naphtha washing and steaming. Approximately half of the naphtha utilized for washing is used as a displacement wash, the other half for "mopping up." The washing cycle is so arranged that the "mopping" naphtha from the previous run is used as a displacement wash in the next run. The "dirty" wash naphtha is reduced and returned to the clean naphtha storage tank.

Provisions are made for revivifying the X-YTE by burning in a multiple hearth clay burner. Both unburned and burned clay storage are provided so that the clay burner operates continuously at the average consumption rate. A clay conveying and elevating system is provided so that any one filter may be emptied of or filled with clay in an hour. The clay burner shaft and rabble arms are provided with air cooling for protection against burning out. The warm air discharge from this cooling system is used in keeping warm the burned clay in the intermediate storage bin so that the filters can be charged with warm clay and also for keeping a constant temperature in the filters during the filtering cycle.



X-YTE PERCOLATION FILTRATION PROCESS

COURTESY, MAX B. MILLER & COMPANY, INC.

Sun-Alco Propane Process

THE SUN-ALCO process herein described, developed jointly by the Sun Oil Company and Alco Products, differs from commercial processes previously described in the literature in three essential respects:

1—Continuous chilling as opposed to batch.

2—Indirect chilling in low propane dilution as opposed to auto-evaporative cooling of relatively high propane dilution blends.

3—Simultaneous deasphalting, deresining and dewaxing as opposed to separate steps of deasphalting, dewaxing and deresining.

This process uses an optimum proportion of propane in the original blend and during indirect refrigeration, to obtain the final results, depending upon the stock or material being processed. As low as 10 percent propane may be used, as for example on certain wax distillate stock. As high as 5 parts propane to 1 of oil may be used for processing light colored residual stocks. In any case the blend is chilled by indirect exchange refrigeration to accomplish about 90 percent of the total refrigeration, the final temperature being accomplished by auto-refrigeration. Propane is separately chilled by a combination of indirect exchange-recovery and auto-evaporation, and used for final dilution requirements by mixing with the original blend at the outlet of the scraped surface exchangers or in the final cooling-evaporation stage. The control of conditions of the indirect chilling, the cold propane dilution and the final chilling of the mixture results in:

1—Fast chilling.
2—Efficient recovery of refrigeration.
3—High filtering rates.
4—High oil recovery.
5—Uniform continuous results.

Dewaxing Distillate vs. Residua

In regard to combined deasphalting, dewaxing, deresining: this is particularly attractive for handling topped Mid-Continent crude. The dewaxing capacity is determined by the amount of lubricating oil required and the wax-resin-asphalt is a by-product of good cracking value and is returned to the topped crude storage or cracking charge.

In cases where commercial waxes are required this component is obtained by distilling the filter residue and fractionating the waxes into cuts bearing the range of melting points desired and sweating these fractions. This operation eliminates the primary vacuum distillation for asphalt removal.

Mid-Continent Residuum Operation

Mid-Continent crudes are therefore handled as "topped crude," replacing the primary vacuum distillation by propane treatment, which also replaces to a large extent acid treatment. As an example of operation on Mid-Continent topped crude, a blend is made of topped crude and propane using a ratio of 1:1. This mixture is pumped through a mixing device directly into a scraped surface type of chiller where it is cooled to minus 25°F. by exchange against processed oil solution. Upon leaving this exchanger there is added cold propane to bring the final dilution to approximately five parts of propane to one part of topped crude. This mixture is then chilled to the final separating temperature by auto-evaporation and the mixture is then separated into oil-propane and a "filter residue." The oil mixture is used as refrigerant for indirect exchange on both the feed mixture and the propane, and then depropanized. The "filter residue" bears only a small part of propane but its refrigeration may also be recovered before depropanizing. The results are summarized as follows:

1—The propane treated topped crude carries all the viscuous neutral, which when separated into fractions are of good stable color, good oxidation value, low carbon residue, and low paraffin content.

2—A large yield of light colored, sweatable waxes can be distilled from the "filter residue."

3—The propane treated topped crude can be redistilled without degradation, and/or can be further solvent treated for Viscosity Index improvement, or distilled into fractions, thus producing the maximum percent of light bodied, light colored oils at the lowest treating, distilling and filtering costs.

The simple flow of the process, in addition to the high rate of separation, more than justifies the residuum process, in comparison with a distillate system, or a deasphalting residuum system for mixed-base Mid-Continent Crude.

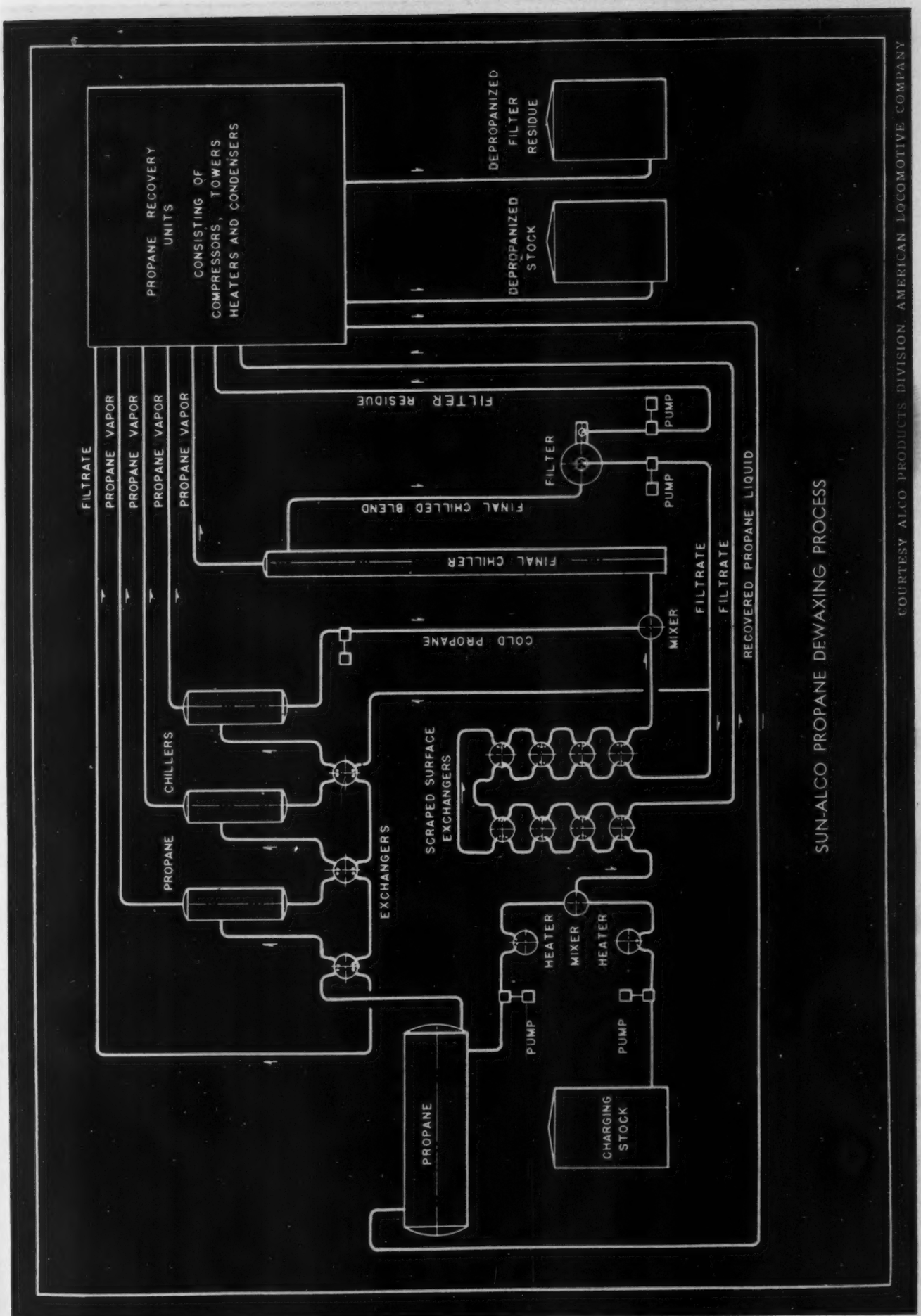
Pennsylvania Lubricating Stock Operation

Pennsylvania crude can be processed as a long residuum and the primary distillation eliminated, In this case the petrolatum obtained would be distilled into the wax fractions for sweating and finishing and the dewaxed oil redistilled into neturals and bright stock. Pennsylvania type crude and refinery practice also justify a combination process—viz., by primary distillation, prepare a wax distillate of 100 vis. @ 100°F. and the conventional steam refined stock, and then process these two stocks separately, but simultaneously, for the production of neutrals, sweatable wax, bright stock and a dark, low oil content, petrolatum. This method applied to Pennsylvania Crude for lube production, gives:

1—Low plant cost and inventory of stocks in process by continuous parallel system.
2—Reduces decolorizing costs to a minimum.
3—Gives maximum oil recovery from wax distillate and Cylinder stock.
4—Gives good filter rate on wax distillate without reblending petrolatum in the chilling stage.

Summary

1—Accurate control of blend for continuous chilling and filtering requirements.
2—Indirect chilling through exchange refrigeration carrying blend to within 20-30° F. of filtering temperature (also carrying much of the cold propane chilling load by exchange).
3—Low quantity of material in process due to continuous chilling at fast rates.


SUN-ALCO PROPANE DEWAXING PROCESS
COURTESY ALCO PRODUCTS DIVISION, AMERICAN LOCOMOTIVE COMPANY
PROPANE RECOVERY UNITS
CONSISTING OF COMPRESSORS, TOWERS HEATERS AND CONDENSERS
DEPROPANIZED FILTER RESIDUE
DEPROPANIZED STOCK
FILTRATE
PROPANE VAPOR
PROPANE VAPOR
PROPANE VAPOR
PROPANE VAPOR
FILTER RESIDUE
PUMP
FILTER
PUMP
FINAL CHILLED BLEND
FINAL CHILLER
COLD PROPANE
MIXER
FILTRATE
FILTRATE
RECOVERED PROPANE LIQUID
PROPANE CHILLERS
SCRAPED SURFACE EXCHANGERS
EXCHANGERS
HEATER
MIXER
HEATER
PUMP
PUMP
PROPANE
CHARGING STOCK

Copper Sweetening Process

Various methods of treating gasoline with reagents comprising copper compounds have been suggested for many years, but the only commercially successful processes of sweetening with copper solutions are those recently developed by Phillips Petroleum Company, which have been available to other companies by licensing arrangements through Petroleum Engineering Research Company and the L. S. Gregory Company, Tulsa, Oklahoma, the exclusive agent, since early in 1936. The processes are widely used, but have been especially rapidly adopted in the Mid-Continent area, where several dozen installations are in operation.

The processes take advantage of the oxidation of mercaptans by cupric chloride, and the subsequent regeneration of the copper chloride with oxygen as shown by the equations:

$$(1)\ 2\,RSH + 2\,CuCl_2 \rightarrow RSSR + 2\,CuCl + 2\,HCl$$

Mercaptan + Cupric Chloride → Disulfide + Cuprous Chloride + Hydrochloric Acid

$$(2)\ 2\,CuCl + 2\,HCl + \tfrac{1}{2}\,O_2 \rightarrow 2\,CuCl_2 + H_2O$$

Cuprous Chloride + Hydrochloric Acid + Oxygen → Cupric Chloride + Water

$$(1) + (2)\ \ 2\,RSH + \tfrac{1}{2}\,O_2 \rightarrow RSSR + H_2O$$

Mercaptan + Oxygen → Disulfide + Water

As shown by the equations, one of the advantages of the process is the theoretical absence of chemical consumption in the sweetening step. In practice it is necessary only to make up mechanical losses of the treating solution, and chemical costs have frequently been reduced to less than 10 percent of the expenditure required by the best of the older methods. Other operating charges are reduced, particularly labor costs, because of the simplicity of the method.

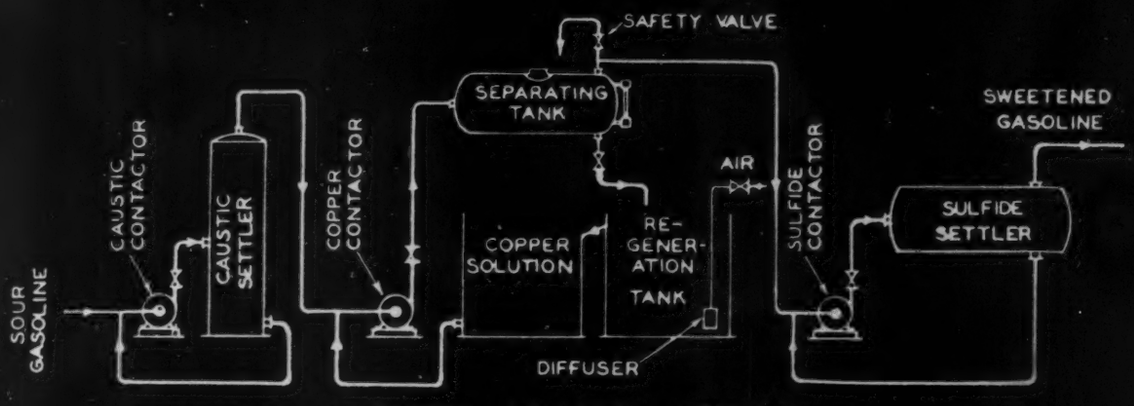
Other savings, however, overshadow the reduction in operating cost. The elimination of gasoline loss, due to treatment in a closed system and complete separation from the treating solution, contributes substantial savings. Probably the most important item is the improvement in quality of the copper treated product as compared to the product resulting from other sweetening methods. The usual loss in octane number incurred in sweetening with lead compounds is eliminated, with consequent savings of considerable magnitude in tetraethyl lead requirement. The product is also more responsive to gum inhibitors, if these are used; without gum inhibitors the various gum tests are usually better than when the stock is treated in other ways. The product is unusually stable when exposed to sunlight, with respect to both color and to corrosion test. All of these effects are due to the absence of the deleterious higher alkyl polysulfides (trisulfides, tetrasulfides, etc.) to which the mercaptans are partially converted, along with the desired disulfides, in other sweetening methods. Copper sweetening can form only the disulfides, since no additional inorganic sulfur is present in any form during the reaction. In the treatment the sulfur content is, of course, unchanged.

The process is applicable to any stock requiring sweetening, and is especially suitable for those of a very sour nature since these are handled just as easily as those that are less sour, and at only slightly greater cost due to increased air requirements. The method is applied in two ways—for stocks which are sufficiently stable to color and gum when treated in the presence of air, the gasoline is mixed with air and filtered through a bed of adsorbent material impregnated with the copper reagent; other stocks are treated with a solution of the copper reagent, and the reagent is regenerated in a separate tank. The oxidizing power of the solution is controlled by varying the extent of the regeneration, thus minimizing side reactions with unstable hydrocarbon constituents of the stock. To insure color stability, the stocks treated with the copper solution are given a final wash to remove any traces of copper remaining in the treated oil.

The flow diagram illustrates the two methods. In both processes the stock to be treated is first given an alkaline wash to remove all hydrogen sulfide and elementary sulfur. If these are not present, as often is the case, this preliminary washing can be omitted. In the solution process the stock is then contacted in a centrifugal pump with the treating solution. The mixture passes to a separating tank, from which the used solution is continuously withdrawn to the regenerating tank where it is blown with a controlled amount of air to give a solution of the desired oxidizing potential. For maximum efficiency in the regeneration, the air is introduced through porous diffusers at the bottom of the tank. The regenerated solution overflows to a solution storage tank and is then recycled. The gasoline is continuously withdrawn from the top of the separating tank and is given a final wash with the stabilizing solution, settled, and run to storage. In the other method, the hydrogen sulfide-free stock is mixed with a predetermined quantity of dissolved air, filtered through the reagent, and sent directly to finished storage.

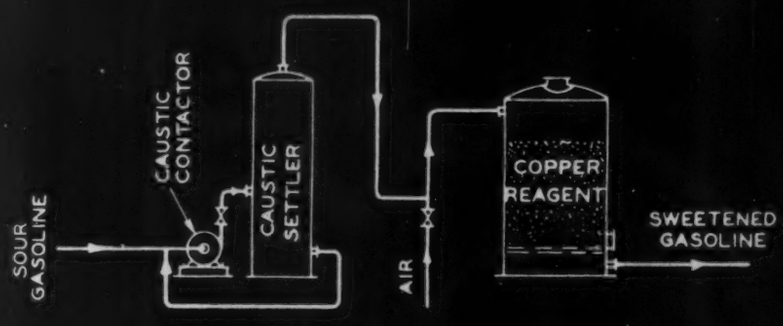
In the solution treatment all equipment in contact with the treating solution, which is highly corrosive to ordinary metals, is constructed of corrosion resisting materials. The separating tank is generally made of Haveg. The solution storage and regenerating tanks are usually made of wood, but some plants use steel or concrete tanks with acid proof linings. The contacting pump is constructed of Durichlor metal. Solution lines may be of Haveg, Durichlor, or rubber lined steel. Valves and fittings are Durichlor. In the filtration process, corrosion is not severe and ordinary materials are used throughout.

Due to compactness of equipment and to the relatively small size for a given throughput, the total installation costs are low even though part of the equipment is relatively expensive.



COPPER SOLUTION METHOD

PERCO COPPER SWEETENING PROCESS



FILTRATION METHOD

COURTESY, PETROLEUM ENGINEERING RESEARCH COMPANY

Howard Treating Process

THE HOWARD PROCESS is a new development in the treatment of light petroleum distillates—both cracked and straight run products. It is the culmination of several years investigative and research work carried on by the Petroleum Research Corporation, 403 Walsix Bldg., Kansas City, Mo., with research and development laboratory at 3226 Sand Springs Road, Tulsa, Oklahoma.

In its essence, it is a vapor-phase treating process, comprising a single once-through operation which depends upon a consecutive series of chemical and catalytic reactions and interactions to efficiently perform the treating functions. The mechanical equipment is so arranged as to permit the various reactions to proceed under conditions favorable for effecting those results desired. The following functions are effected, namely: removal of objectional gums and gum forming materials; excellent stabilization toward oxidation, and sunlight; production of negative doctor and negative corrosion; appreciable sulphur reduction; production of good color and color stability; retention of inherent octane value; appreciable improvement in tetraethyl lead susceptibility; and, low treating losses.

Briefly, the process comprises a system wherein the raw vapors are first subjected to intimate and uniform treatment with chlorine gas; providing for removal of any resultant polymerized fractions from the vapors; then leading the treated vapors into a contact vessel where they intimately contact a solid reagent, the active ingredient of which is an oxidized form of zinc, metallic zinc, or a mixture of both; thereafter leading the vapors into a fractionating tower of conventional design for the purpose of securing proper end point and elimination of any heavy liquid polymer carry-over; and finally condensing the vapors. The active ingredient in the contact vessel is carried in a solid binder, in which it is uniformly dispersed. The contact material is a manufactured product of specification materials. All heavy end fractions and polymers return to a stripper tower to denude them of their gasoline content, and from there the denuded polymers pass to fuel oil or cracking stock as is found desirable. The condensed gasoline is led to finished storage.

Operating temperatures are those inherent to the vapors at system pressures ranging between 15 and 25 lbs. gage. Automatic controls can readily be applied where required. Treating is effected with a minimum of chemical reagent, chlorine consumption varying between 0.05 lb./bbl. and 0.25 lb./bbl., while the contact bed can be periodically reactivated by simple steaming.

A number of applications of the process are permissible and any specific installation is governed principally by the type of stock to be processed. Cracked distillates of a very refractory nature and carrying comparatively high sulphur contents are preferably stabilized first to eliminate propane, hydrogen sulphide, and excess butane, before being subjected to treatment. Milder types of cracked distillates lend themselves to processing in direct connected units, where the processing unit becomes an integral part of the cracking system. Insertion of the treating unit between the fractionating column and the condenser, providing for direct-connected operation, is prescribed in the treatment of straight run gasoline. The combined gasoline and kerosene vapor cut may be treated as a whole, with fractionation and separation of the gasoline and kerosene provided for in a following tower. Both the cuts will be sweet, noncorrosive, and with major reduction of sulphur.

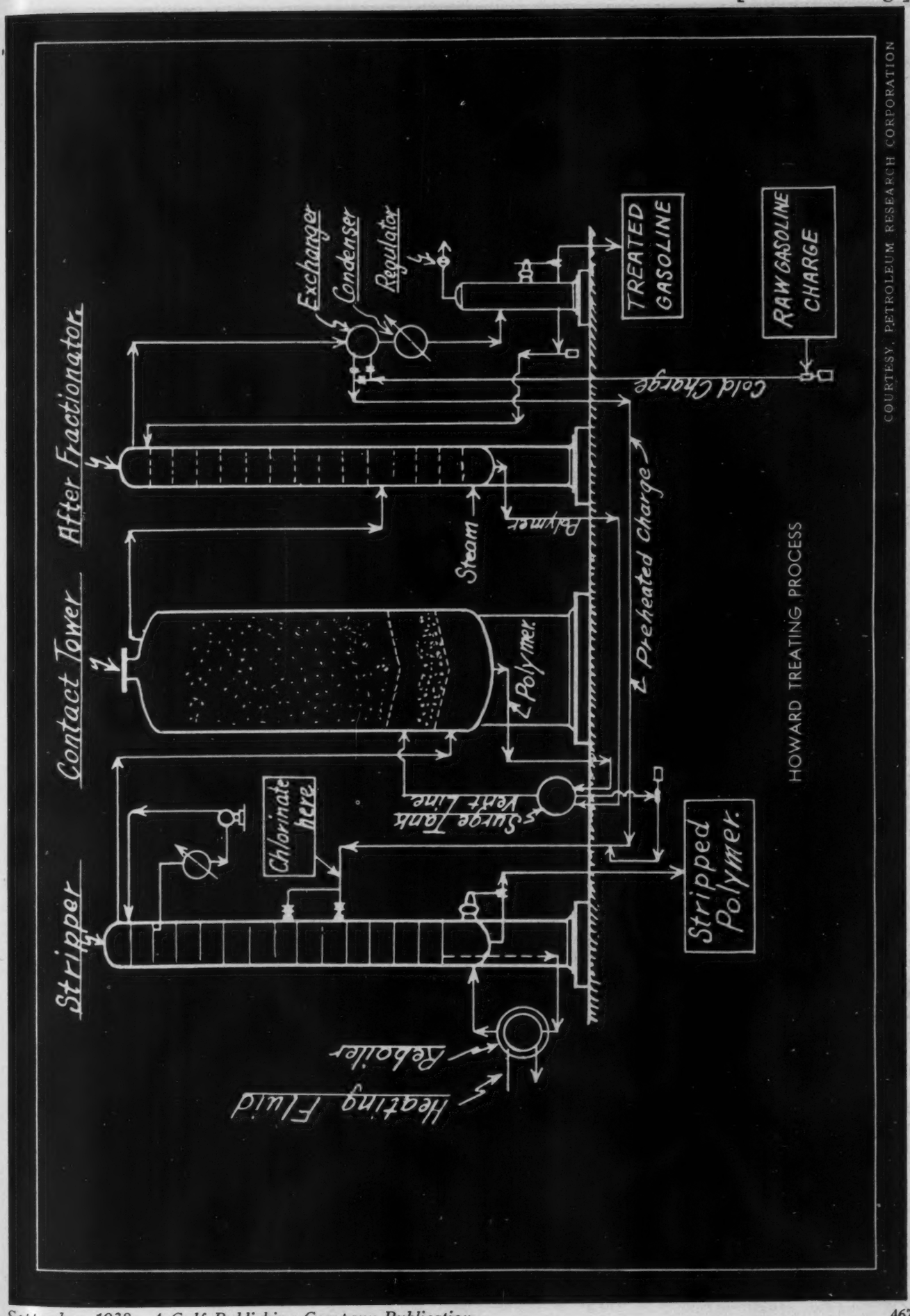
Many different types of products have been successfully treated. These products include cracked products produced from the conventional type cracking processes including vapor phase and polymerization units, and from stocks originating from a wide range of territories. Many straight run products have been treated, these ranging from comparatively low to comparatively high sulphur and mercaptan contents. In the once-through operation the process gives the combined results of a gum treatment, a sweetening treatment, sulphur reduction, color and gum stabilization, and improved lead susceptibilitv.

In the matter of gum removal, gasolines after treatment show contents of from 2 to 12 mgs. by copper dish, but seldom show any gum by glass dish. Different type stocks account for difference in gum content. Good stability is secured. The induction period has also been found to vary, according to the type of material treated. Vapor-phase gasolines and those produced by high temperature cracking show from 6 to 10 hours induction period, but the average cracked gasolines from the conventional types of cracking processes show generally higher induction periods, in some instances going to as high as 30 hours. The long induction period, being indicative of good storage stability, is of considerable interest to those storing finished gasoline for a considerable time period prior to shipment.

All products recovered from the treating unit are 30 color, and it has been demonstrated many times that both cracked and straight run products are exceptionally stable to sunlight. No haze, cloud, or deposition upon the walls of the vessel occurs after many hours exposure. Effective elimination of deleterious sulphur compounds renders the finished products doctor sweet and non-corrosive, with odor agreeably pleasant and sweet.

The sulphur reduction is appreciable, averaging on all products in the order of 50 percent. The sulphur reduction varies, however, with different stocks and the general average reduction is 10 percent more on straight run products than on cracked products. A minimum reduction of 15 percent has been found on some products while a maximum reduction of 80 percent has been found on others. The difference of chemical nature of the sulphur compounds in the various stocks account for the difference in sulphur reduction; some sulphur compounds being readily susceptible to this type treating. Numerous determinations have shown that the total sulphur reduction is always equal to and usually greater than the mercaptan sulphur content of the raw stock.

No degradation of the product either as to octane or lead susceptibility is occasioned by treatment. On the contrary, there is a marked improvement in most cases and the magnitude of the improvement is tied in with the sulphur reduction, and obviously closely related to it. Appreciable economies are therefore possible in those instances where additions of tetraethyl lead are used to improve octane. Savings on the order of 50 percent are shown on straight run gasolines, while cracked products show a variation of from as low as 10 percent to as high as 40 percent.


Stripper
Contact Tower
After Fractionator
Exchanger
Condenser
Regulator
TREATED GASOLINE
RAW GASOLINE CHARGE
Cold Charge
Steam
Polymer
Preheated Charge
Polymer
Chlorinate here
Surge Tank
Vent Line
Stripped Polymer
Heating Fluid
Reboiler
HOWARD TREATING PROCESS
COURTESY, PETROLEUM RESEARCH CORPORATION

Lachman Treating Process

THE Lachman Process for treating gasoline was invented by Dr. Arthur Lachman of the University of California, and was developed cooperatively with the technical staff of Richfield Oil Company.

Fundamentally the process covers the treatment of hydrocarbons by intimate contact with maintained solutions of metallic salts. The process broadly covers such reagents as the sulfates, halides, nitrates, or other water soluble salts of aluminum, cadmium, cobalt, copper, chromium, iron, manganese, mercury, nickel, or zinc. Inasmuch as zinc chloride is quite effective and is universally available at low cost, it has been generally adopted for use in the Lachman process.

In commercial operations, the process has been applied chiefly to the treatment of cracked gasoline. The cracked distillate is vaporized and is then brought into intimate contact with the aqueous zinc chloride solution in a suitably designed contact tower. The zinc chloride, containing the polymerized oils is drawn off at the bottom of the tower, the polymers are separated and removed, the zinc chloride is filtered, diluted to proper concentration and returned to the system. The treated vapors pass from the top of the contact tower to a neutralizing tower filled with lump limestone in which any hydrochloric acid formed by hydrolysis is removed, and then to a fractionating tower for the further removal of polymers and adjustment of end point. The vapors are then condensed and go to storage. A light doctor treatment is usually necessary to give a sweet product. In practice the process can be carried on either directly in connection with the cracking unit, treating the vapors as they leave the cracking plant bubble tower, or in a rerun unit, the choice being generally determined by the amount of hydrogen sulfide present in the gases from the cracking plant. If this quantity is great, it is usually preferable to condense the cracked distillate, remove the dissolved hydrogen sulfide by stabilizing or otherwise and then Lachman treat on a rerun basis.

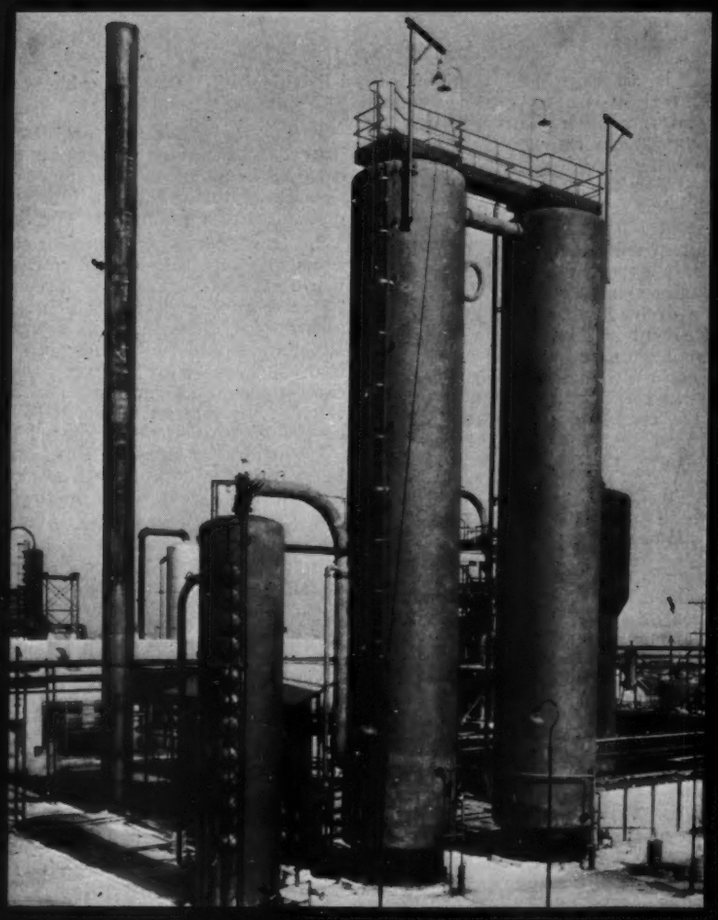
One of the important advantages of the process is its extreme flexibility. The ultimate aim of any process based on selective polymerization is to remove all of the unstable gum and color forming bodies without removing any of the valuable hydrocarbons. That the Lachman process is highly successful in doing this is due to the very close control that the operator has over treating conditions. The factors which influence treating are (1) intimacy of contact, (2) concentration of the treating medium, (3) time, (4) temperature. In the Lachman process, two of these factors, intimacy of contact and time, are functions of design; the other two, concentration and temperature, are functions of operation, at all times under the control of the plant operator. Thus, distillates from gas oil or fuel oil cracking which normally require rather heavy treatment and reformed or vapor phase cracked distillates which are very readily polymerized and require light treatment can be handled by the Lachman process to give maximum treatment with minimum losses.

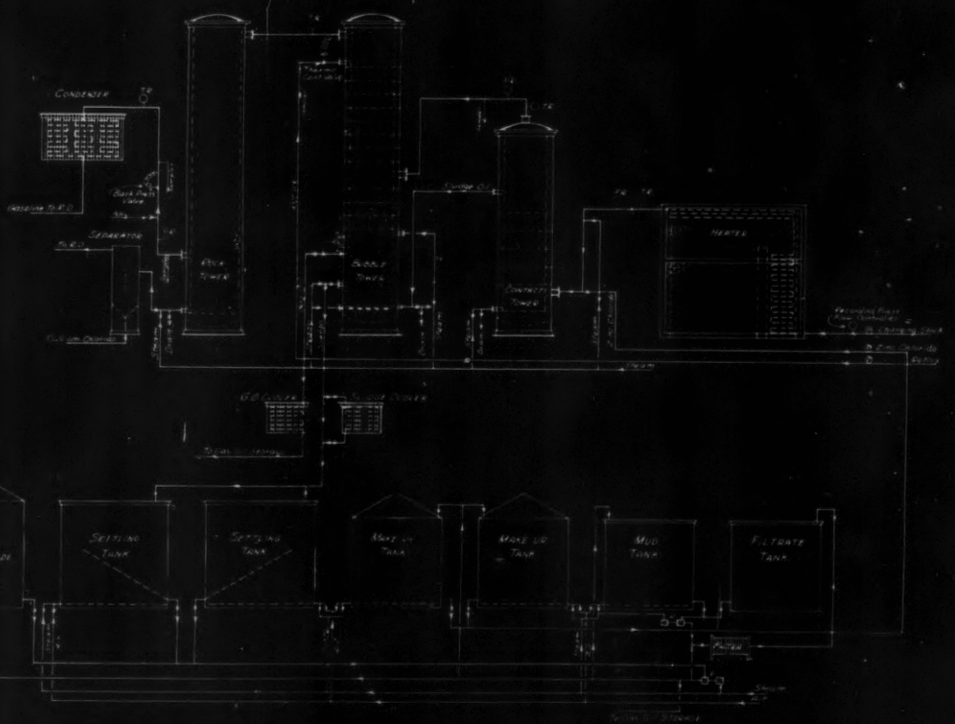
An important advantage of the process is the ability to maintain the concentration of the treating solution at any desired point. When hot vapors are passed through a salt solution, water is driven off and the solution becomes more concentrated. In the Lachman process the concentration required for proper treatment is first determined by experiment and can then be maintained reasonably constant. To do this it is necessary to control both temperature and water-vapor pressure. Where the temperature is fixed by other conditions, water-vapor pressure is the factor to be adjusted. This can be done by the continuous addition of steam to the unit.

The apparatus used in the process is of the kind usually found in any refinery. Any type of pipe still may be used for a source of heat in the rerun type of operation. The contact tower must be designed to give intimate mixing of the vapors and zinc chloride solution and proper time of contact. Mixing is accomplished either by the use of tower packing, slotted plates, or bubble caps. Due to the corrosive nature of hot, concentrated zinc chloride solutions, the contact tower is usually lined with acid resisting brick. Any type of chemical tile may be used for packing and corrosion resisting metal is employed for the mixing plates or bubble caps. Brass or bronze has been found satisfactory for this purpose. The neutralizing tower is simply a steel shell, brick lined. A grid is placed in the bottom to support the limestone which is added through the top manhole as required. The final fractionating tower is of standard design. The equipment used for recovering the zinc chloride solution consists of ordinary steel settling and dilution tanks and a filter of any standard type.

The process has operated successfully on distillates from nearly every commercial cracking or reforming process, including vapor phase, viscosity breaking, reforming, gas oil cracking, etc. Units of the process have been installed in the United States, Canada, France, Germany, Roumania, and British South Africa.

In general the process operates to produce a cracked distillate of low gum, good color and excellent color and gum stability. The octane rating of the gasoline treated is not affected. The process has some effect on sulfur reduction, depending on the form in which the sulfur is present, mercaptan sulfur being more readily removed than other forms. The process is licensed to the industry by Richfield Oil Corporation, Richfield Bldg., Los Angeles, California.





LACHMAN TREATING PROCESS

COURTESY, RICHFIELD OIL CORPORATION

Stratco PbS Sweetening Process

THE Stratco PbS Process is an improved method of sweetening all types of straight-run or cracked sour gasolines in a most economical manner. This Process is continuous in operation and it consists of intimately contacting the sour gasoline with preformed, dense and quick-settling lead sulfide which is suspended in a strong caustic soda solution. To this mixture is fed a very small, positively regulated quantity of air, continuously, for the purpose of activating the PbS Reagent; also, a sufficient quantity of sodium sulfide solution is continuously fed to the mixture for the purpose of precipitating color bearing, or color forming, lead salts formed in the PbS Reagent during the sweetening operation or lead salts which may be in solution in the oil. The PbS Reagent is thus kept in desirable chemical balance and the sweetening operation is accomplished as a catalytic oxidation under controlled conditions such as to avoid the formation of substantial quantities of undesirable chemical compounds (thiosulfates, etc.) and consequent loss of treating chemicals.

The chemicals required for the PbS Process are:

1. Sodium Sulfide Solution.
2. Strong Caustic Soda Solution.
3. Plumbite Solution.
4. Air.

(a) The sodium sulfide solution is required in order to bring about the precipitation of all soluble lead compounds dissolved either in the oil under treatment or accumulating in the PbS Reagent, into the form of dense, pulverulent lead sulfide.

(b) Strong caustic soda solution is required to maintain the proper active quality of the PbS Reagent, i.e., principally to compensate for the progressive dilution of the initial strong soda solution, owing to the formation of water during the sweetening chemical reactions.

(c) Plumbite solution is necessary in order to compensate for the loss of small quantities of lead which may be mechanically lost during the sweetening operation, or during the washing of the PbS Reagent. It is to be especially noted that there is no chemical consumption of lead in any form involved in the PbS sweetening process.

Chemical Reactions—The chemical reactions shown are generally accepted in the petroleum industry as being representative of the reactions which occur in doctor sweetening and doctor regeneration. Those shown relating to PbS sweetening are not so well defined, as in doctor sweetening, but they do indicate one reasonable explanation of the total overall reaction.

Plumbite Method

1. $PbO + 2NaOH \rightarrow Na_2PbO_2 + H_2O$
2. $2RSH + Na_2PbO_2 \rightarrow (RS)_2Pb + 2NaOH$
3. $(RS)_2Pb + S \rightarrow R_2S_2 + PbS$

Doctor Regeneration

4. $2PbS + 2O_2 \rightarrow PbS_2O_3 + PbO$
5. $PbS_2O_3 + 4NaOH \rightarrow Na_2PbO_2 + Na_2S_2O_3 + 2H_2O$
6. $PbO + 2NaOH \rightarrow Na_2PbO_2 + H_2O$

PbS Process

7. $PbS + \frac{1}{2} O_2 \rightarrow PbO + S$
8. $PbO + 2NaOH \rightarrow Na_2PbO_2 + H_2O$
9. $2RSH + Na_2PbO_2 \rightarrow (RS)_2Pb + 2NaOH$
10. $(RS)_2Pb + S \rightarrow R_2S_2 + PbS$

Upon examination of this series of reactions, it is seen that the lead sulfide acts substantially as a catalyst which enters into the reaction and is regenerated and that the net reaction of the series is one of oxidation as follows:

11. $2RSH + \frac{1}{2} O_2 \rightarrow R_2S_2 + H_2O$

Advantages of PbS Process

1. Minimum Chemical Costs
2. Negligible Losses of Gasoline
3. Least Octane Degradation
4. Often Improves Lead Susceptibility
5. Eliminates Use of Sulfur
6. Best Color Retention
7. Continuous and Automatic Operation
8. Unusually Low PbS Plant Cost
9. Conversion Doctor Plants Inexpensive
10. Sweetens All Gasolines
11. No Corrosive Chemicals Used
12. Proven by Large Commercial Operation

The Stratco PbS Sweetening Process is remarkably economical, as compared to conventional doctor sweetening, and it is chemically more desirable and advantageous for the following reasons:

1. *No Sulfur Added for "Break"*—Sodium sulfide is added instead of sulfur in performing PbS sweetening, therefore, the sulfur content of the sweetened gasoline is not increased over its original sulfur content in the unsweetened condition, and the difficulties of regulating sulfur feed are removed.

2. *"Black-Strap" Emulsions Eliminated*—No non-settling, flocculent lead sulfide is formed by the PbS process. In other words, the PbS sweetening process is entirely free of so-called "Black-Strap" emulsion which is such a stable emulsion as to always give difficulty in its separation, as in the case of doctor sweetening. All lead sulfide, in suspension in the PbS Reagent, is of a dense, quick-settling, pulverulent character which, in no case, causes the formation of troublesome oil-reagent emulsions. Such oil-reagent emulsions as "Black-Strap" are the chief cause of the loss of much sweetened gasoline during the separation of spent doctor solution. Further, "Black-Strap" emulsion must be continuously removed, separated, and regenerated, which leads to high accumulated losses of chemicals and gasoline.

3. *Gasoline Losses*—The loss of sweetened gasoline by the PbS process is negligible; hence, one of the most serious sources of gasoline loss now suffered by refiners who use doctor sweetening, is wiped out. The PbS process permits the highest net recovery of sweetened gasoline to be easily maintained. Briefly, the only loss of gasoline that can occur during normal PbS sweetening operation is substantially that of evaporation from run tankage.

4. *Tetra-Ethyl Lead Requirements*—The PbS process makes possible maximum conservation of original octane number of gasoline being sweetened. This materially reduces the quantity of Tetra-Ethyl Lead required to fulfill finished gasoline specifications. These savings normally range from 0.10 to as high as 0.50 cc of T.E.L. per gallon of gasoline. Since no "free sulfur" is used in the process the deleterious effect of such sulfur in any form on octane number is completely avoided.

5. *Inhibitor Susceptibility*—The addition of excess sulfur during the sweetening operation increases greatly the quantity of inhibitor required for a given induction period. It is possible by the PbS process which uses no sulfur to reduce inhibitor requirements as much as 50% for equal induction periods.

6. *Regeneration PbS Reagent*—The regeneration of PbS Reagent consists of the removal from the PbS of a film around the particles made up principally of phenolic or naphthenic bodies by means of washing same with hot water. This washing of PbS Reagent is easily accomplished without loss of chemicals.

The frequency with which PbS Reagent requires washing, as just indicated, naturally depends on the content of the fouling bodies in the sour gasoline treated and, to some degree on the content of mercaptan sulfur in the sour gasoline. It is usually necessary to wash PbS Reagent at intervals varying between approximately two and four weeks of continuous operation.

7. *Automatic Operation*—The operation of the Stratco PbS process is continuous and automatic. Consequently, the consumption of chemicals in this process can be readily held at a minimum and its chemical control reduced to the utmost simplicity.

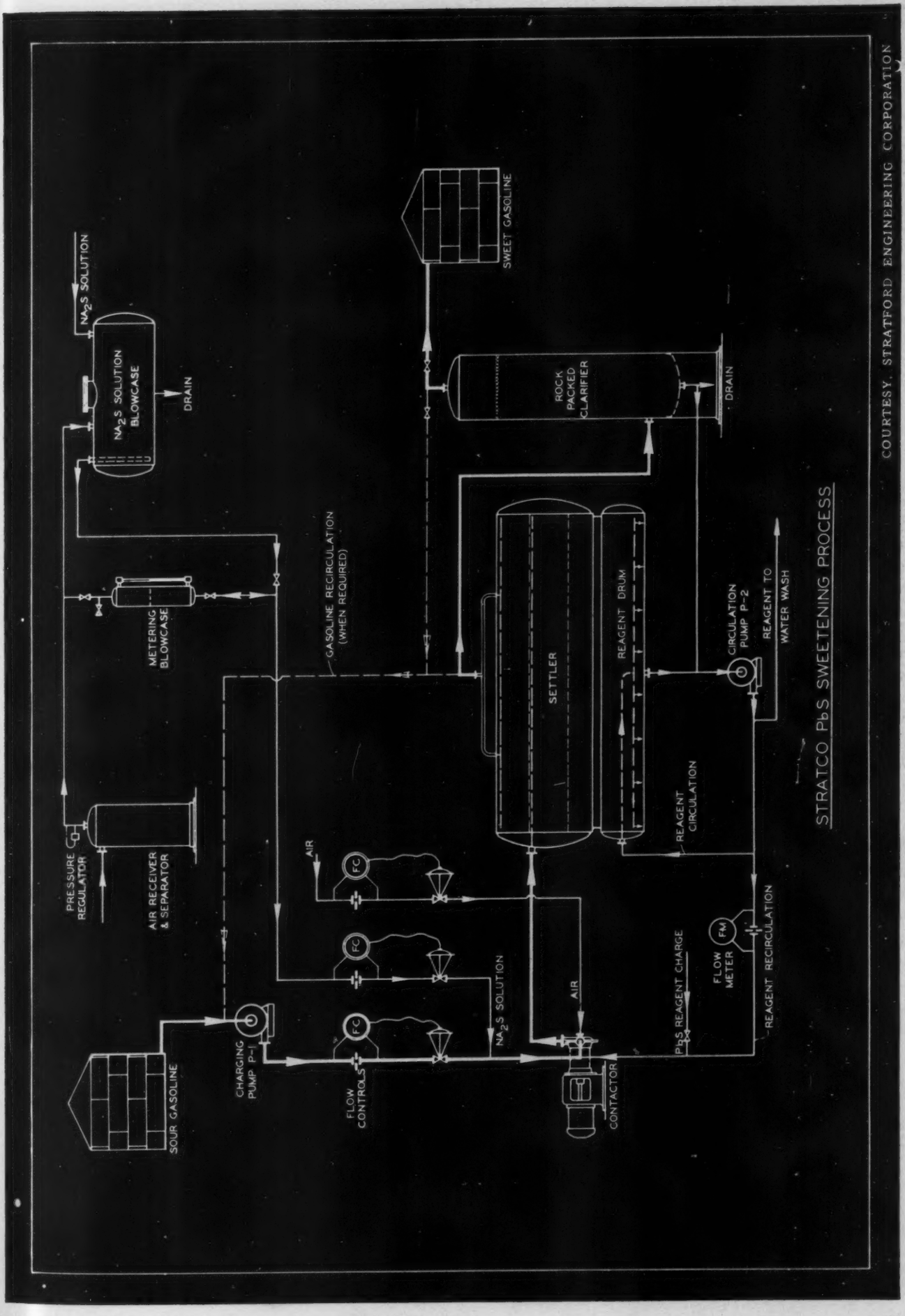
8. *Operators and Utilities*—The PbS process requires the same number of operators as the doctor sweetening method for its satisfactory operation.

The cost of all utilities required by the PbS process is materially less than for doctor sweetening. No air is required for PbS Reagent regeneration and but little steam. In contradistinction, the cost of steam and air required for the regeneration of "Black-Strap" has often been found to be nearly equivalent to the cost of chemicals required. Such a large reduction in the costs of these items represents a substantial saving.

9. *Conversion of Existing Doctor Plants*—It will be noted from the flow sheet of the PbS process that existing doctor sweetening plants can be converted to the PbS process cheaply and without difficulty. In practically all cases most of the equipment can be utilized in making the conversion of existing doctor plants into PbS sweetening plants when desired.

10. *Kerosene Sweetening*—The PbS sweetening process is adaptable with excellent efficiency to the sweetening of kerosene distillates, furnace oils, and gas oil.

This description is furnished through the cooperation of the Stratford Engineering Corporation, Dierks Building, Kansas City, Missouri.


STRATCO PbS SWEETENING PROCESS
COURTESY, STRATFORD ENGINEERING CORPORATION
SWEET GASOLINE
Na_2S SOLUTION
Na_2S SOLUTION BLOWCASE
DRAIN
ROCK PACKED CLARIFIER
DRAIN
METERING BLOWCASE
GASOLINE RECIRCULATION (WHEN REQUIRED)
SETTLER
REAGENT DRUM
CIRCULATION PUMP P-2
REAGENT TO WATER WASH
PRESSURE REGULATOR
AIR RECEIVER & SEPARATOR
AIR
FC
REAGENT CIRCULATION
FM
FLOW METER
REAGENT RECIRCULATION
PbS REAGENT CHARGE
Na_2S SOLUTION
AIR
CHARGING PUMP P-1
FLOW CONTROLS
CONTACTOR
SOUR GASOLINE

U. O. P. Treating Process

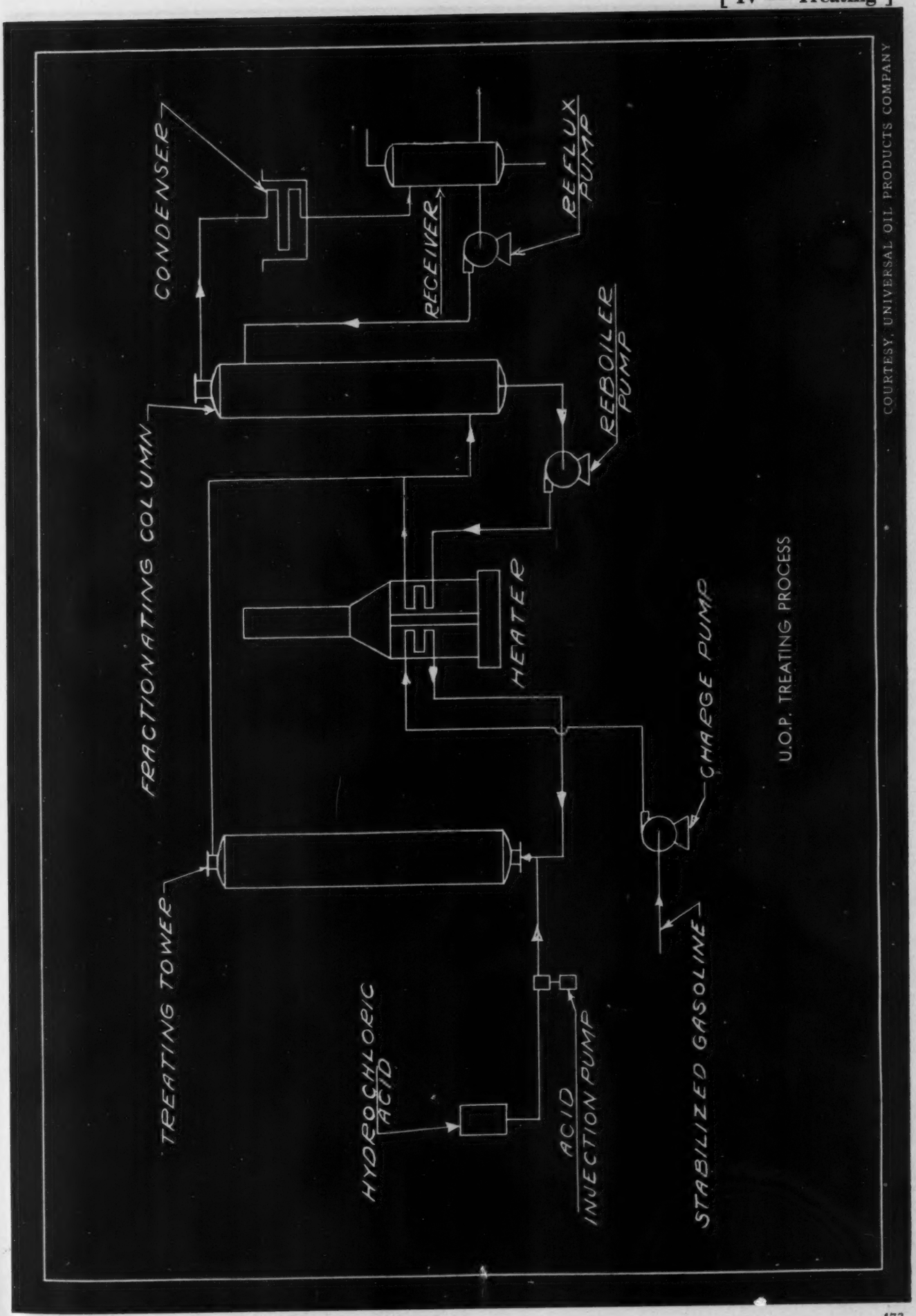
THE U. O. P. Treating Process is a method for the refining of cracked gasoline by the removal of color-forming components. It may be used with cracked gasolines from all sources, and it is particularly applicable where some desulfurization, approximately 25 percent, good color, color stability, gum stability and low gum are required. The refining is effected by a combination of heat and pressure with a catalyst in the presence of hydrogen chloride. The catalyst is a zinc-containing metal or ore. A series of U. S. patents have been issued relating to the process, including 1,920,247, 1,920,248, 1,937,873, 1,970,281, 1,970,282, 1,970,283, 1,970,284, 2,001,185, 2,029,256, 2,029,757, 2,029,758.

In the operation of the process, the raw gasoline from the cracking plant stabilizer is heated by passage through a furnace to a temperature of 450°F. and into a treating chamber containing the catalyst. The raw gasoline is taken from the stabilizer at a temperature of 300°F. Commercial hydrochloric acid is pumped continuously into the tower in admixture with the gasoline. A pressure of 135 lbs. per sq. in. is maintained on the treating tower. The gasoline passes from the treating tower through a pressure reducing valve, to the rerun or fractionating column, which operates at a pressure of 10 pounds. The bottoms in the tower are circulated through a reboiler coil in the same furnace to afford heat for the distillation. The polymers formed during the treatment are withdrawn from the bottom of the column and they are returned to the flash chamber of the Dubbs cracking unit. The overhead vapors are condensed and collected in a receiver from where the gasoline passes to a rundown tank. Reflux in the column is maintained by circulation of the gasoline from the receiver to the top of the column. Ammonia is fed into the vapor line of the fractionating column together with water in order to avoid corrosion at this point.

A typical commercial installation processes 450 barrels of gasoline per day. The outlet of the gasoline heating coil is 460°F. with a top temperature on the treating tower of 450°F. The bottom temperature of the rerun column is 480°F. with the overhead gasoline vapor at 318°F. Approximately 0.70 pounds of commercial hydrochloric acid per barrel of finished gasoline is used. The ammonia consumption is 0.10 pounds of anhydrous ammonia per barrel of gasoline. The treating loss has averaged 2.1 percent. A comparison of the properties of the gasoline before and after treatment under these conditions is as follows:

	Untreated	Treated
Color	Yellow	30
Color Stability (2 hours sunlight)		28
Gum, Copper Dish, mg./100 cc.		6
Doctor		Positive
Sulfur, percent	0.19	0.13
Octane number	69	68.5
Vapor Pressure, Reid, lbs.		11.2
Oxygen Bomb Stability, induction period, minutes		300
Gravity, degrees, A.P.I.		60.9
100 cc. A.S.T.M. Distillation		
IBP		84°F.
5 percent		106°F.
10 percent		120°F.
20 percent		148°F.
50 percent		244°F.
70 percent		302°F.
90 percent		360°F.
EP percent		390°F.
Percent Recovery		96
Percent Bottoms		1

The furnace used in heating the gasoline to the reaction temperature can be substituted with suitable heat exchangers. However, it is justified in the flexibility that it imparts to the operation of the unit. The heater consists of two coils separately fired allowing a close control on the tower and reboiler temperatures. The acid feed system is entirely satisfactory. The use of Hastelloy both in pump construction and in acid transfer lines has proven that this material is well suited to this usage.


CONDENSER
RECEIVER
REFLUX PUMP
FRACTIONATING COLUMN
REBOILER PUMP
HEATER
CHARGE PUMP
U.O.P. TREATING PROCESS
TREATING TOWER
HYDROCHLORIC ACID
ACID INJECTION PUMP
STABILIZED GASOLINE
COURTESY, UNIVERSAL OIL PRODUCTS COMPANY

Bayway Chemicals Recovery Process

NAPHTHA recovery and Doctor regeneration has proven highly profitable in refineries treating gasolines, naphthas, kerosenes and other distillates with alkaline solutions such as sodium plumbite and others. The process as sold to the industry by Bayway Engineering Company, 120 Liberty St., New York, N. Y., consists of a special demulsifier and a mechanical spent doctor regenerator. This system removes practically all of the naphtha or other distillate from the chemicals used for treating, returning the recovered distillate to the refinery stock tanks for use in blending into motor fuels or for charging to the plant as cracking stock.

In treating or sweetening petroleum distillates with sodium plumbite and other alkalies volumetric losses of distillates range from one percent to three percent, and such volumetric losses cost the refiner from $5,000 to as high as $20,000 per year. This loss is eliminated through the use of the Bayway system wherein such volumetric losses are saved. No longer is it necessary to heat spent doctor or black strap with steam and blow it with air, which practice brings about the losses mentioned above, presents a continual fire hazard, and requires much time for evaporation of the naphtha and regeneration of the doctor. The Bayway system operates at atmospheric temperature, no steaming nor air blowing is required and the time factor is reduced many times. Further, the demulsified doctor is much cleaner and freer of heavy naphthas, gum forming substances and similar impurities, which when left in the doctor solution contribute largely to gum and sun stability troubles.

After regeneration the doctor solution is superior to that furnished by the conventional steaming and blowing system. The strength is uniform as is the gravity, and it is free of entrained or off-colored naphtha, and less emulsion trouble and gasoline entrainment in spent doctor is assured.

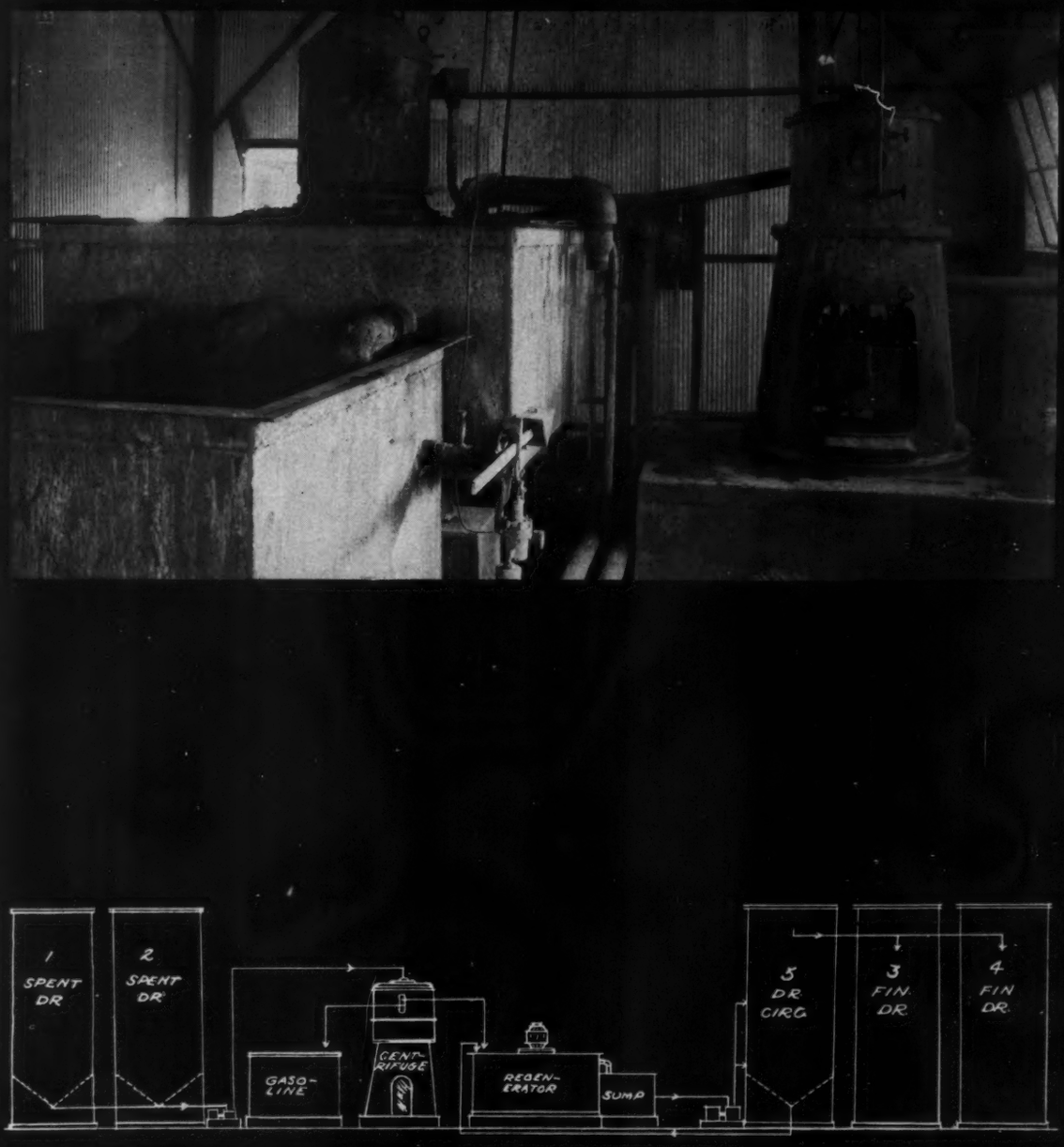
One typical installation consists of one special demulsifier, and one mechanical spent doctor regenerator. The demulsifier has an individual built-in, explosion-proof 2-horsepower motor and is designed for an effective feed rate of 5 to 7 barrels per hour. The regenerator has an individual, built-in, explosion proof, 15 horsepower motor and is designed for an effective regenerating rate of 12 barrels of solution per hour to contain 8 to 10 pounds of soluble lead per barrel of solution.

The demulsifier is a modified continuous solid bowl centrifuge operating at a basket speed of 1250 revolutions per minute. In operation, the feed is forced into the bottom of the bowl and gradually flows upward. The lead sulphide which settles in the bowl is caught up by the blades of a screw operating at slightly different speed from that of the bowl, and moved slowly upward, being freed of naphtha in the process by the centrifugal action. The naphtha, being lighter than the caustic and lead sulphide, flows toward the center of the bowl where it forms a vertical layer and is trapped off to the gasoline discharge through four equally spaced nozzles. The caustic and lead are thrown toward the outside of the bowl by centrifugal action, and upward by the screw blades and find egress through a baffle and slot near the top of the centrifuge. The baffle is so constructed that only caustic and clean sulphide is discharged, holding any emulsified material in the bowl until broken.

The regenerator consists of a shallow, flat bottom tank in the center of which sets the special mechanism of the unit. Essentially, the latter is a suspended, motor-driven rotor surrounded by a cylindrical stator secured to the bottom of the tank and surmounted by a sleeve. The speed of the motor is 490 revolutions per minute. A perforated false bottom of the tank is equipped near the center with radiating ducts in the form of a clover leaf while at the center of the clover leaf is a larger hole directly over which the rotor whirls. The rotor and stator each consist of two cast iron annular rings with pipe spacers to separate the rings. Pipes are placed in such position that the openings between them form long, narrow vertical slots.

In operation, the spent doctor, or centrifuge discharge of lead sulphide and caustic, is introduced into a narrow, vertical channel on one end of the tank from which it is partly drawn and partly gravitates, to the bottom of the tank proper, beneath the false bottom. When enough feed has been introduced to cover the top of the stator slots, the whirling rotor acts as a pump impeller and draws liquid up from the bottom of the tank through the center opening, forcing it out between the pipe spaces on the rotor and into the space between the rotor and stator. Then, by means of its own velocity it is thrown out through the stator slots, being whipped into fine spray in the action. The action likewise creates a vacuum, pulling air from the atmosphere through a pipe rising above the level of liquid in the regenerator. The design is such that this air is mixed intimately with the doctor solution discharging from the stator, the whole assuming the form of a mist. When the mixture strikes the liquid in the tank, larger air bubbles are formed and pass off. The entire regenerating system is made continuous by first, circulation of liquid back to the clover leaf ducts through the feed compartment and through the perforated false bottom, and second, overflow of regenerated solution to a sump provided.

The complete installation consists of the two units described above together with adequate doctor settling, circulating and storage tanks, doctor transfer pumps, and storage facilities for the recovered gasoline. Usually very little in extra equipment is needed besides the centrifuge and the regenerator, the remainder being already present in the form of conventional recovery equipment.



BAYWAY NAPHTHA AND CHEMICALS RECOVERY SYSTEM

COURTESY, BAYWAY ENGINEERING COMPANY

Petreco Electrical Desalting Process

THE well known settling methods, used by refiners for the purpose of removing salt and other solid materials from crude charging stocks, have become unsatisfactory due to their failure to remove a large part of these substances. This has been particularly true when it was necessary to handle large volumes of oil. The electrical process developed by Petroleum Rectifying Company has been found capable of removing over 90 percent of the water soluble solids and other corrosive substances usually present. It also effectively removes a large portion of suspended insoluble matter, such as sand, iron, sulfide, volcanic ash, etc. Large volumes of oil can be handled without any difficulty and with a minimum amount of equipment.

The process is carried out by emulsifying a quantity of fresh water into the oil and then passing this emulsion through a high potential electrostatic field where the emulsion is rapidly broken down and the water removed. During the passage of the emulsion through the charged space, the drops of emulsified brine, together with any crystalline solids, are coalesced with the fresh water particles and are removed from the oil along with the fresh water. The process is continuous and can be tied into the refinery stream so that the oil is purifiied as it goes to the stills.

The quantity of fresh water required ranges between 10 and 20 percent of the volume of oil being cleaned. The nature of the oil and the concentration of salt determines the amount of water. The operating temperature runs between 150 and 200°F. The water is emulsified into the oil by running the mixture through a pressure reducing valve. The drop across this valve varies with the type of oil being processed. Pressure drops range from 3 to 50 pounds per square inch.

Since the process operates by virtue of high-tension electrostatic forces, there is very little power consumption. The average power requirement is 2 KW per unit, with a maximum demand of 10 KW per unit.

The process has been applied to oils from Michigan, Ohio, Illinois, Kentucky, Kansas, Oklahoma, West Texas, and the Gulf Coast. Some of these oils have contained as high as 1100 pounds of salt per thousand barrels; others will average 30 to 40 pounds. In general, the salt reduction is in the order of 90 to 95 percent with a corresponding reduction in all corrosive substances except sulfur. In cases where 90 percent reduction leaves the salt content too high, the process can be two staged with little additional expense.

The standard size desalting unit consists of a pressure vessel 10 feet in diameter by 12 feet high, designed for a working pressure of 35 pounds. Inside this vessel the high-tension electrodes are mounted on the proper insulators. The emulsified oil is injected into the electric field at high velocity through a special nozzle.

After passing through the electrodes, the oil and water separate into two layers and are drawn from the vessel in continuous streams. The emulsifying device is mounted outside and adjacent to the dehydrator. Any number of these units can be installed in a battery, so that there is no limit to the capacity of the installation. For multiple unit operation it is customary to install one or two emulsifying valves to handle the whole stream, then divide this stream between the dehydrating units. The units are manifolded together and water levels maintained by automatic control. Electric power control is maintained by individual switch gear operating at either 220 or 440 volts.

The process is licensed by Petroleum Rectifying Company, Los Angeles and Houston.

PETRECO ELECTRICAL DESALTING PROCESS
COURTESY, PETROLEUM RECTIFYING COMPANY
TO STILLS
LEVEL CONTROL
AIR OPERATED VALVE
AIR LINE
STEAM TO PUMP
CRUDE PUMP
METER
WATER SUPPLY
SURGE DRUM
EMULSIFYING VALVE
HEAT EXCHANGER
BACK PRESSURE VALVE
CLEAN OIL (35 lbs per sq in)
DE-SALTER
DE-SALTER
SALT WATER DISCHARGE
(40 lbs per sq in)
CRUDE TO TREATERS (150° - 200°)

Diethylene Glycol Process

FOR DEHYDRATING NATURAL GAS

NATURAL gas normally contains a certain amount of water vapor. Unless the water content is reduced so that no condensation occurs under the conditions of temperature and pressure existing in natural gas transmission lines, operating difficulties are likely to develop. Moisture causes internal corrosion and rust accumulations. Water condensing at the low points in the transmission line must be drained off from time to time to prevent stoppage and freezing. In addition, at high pressures and in the presence of liquid water, solids known as natural gas hydrates may form, which resemble snow and build up in the line, seriously interfering with its capacity. At high pressures these hydrates may have melting points as high as 50-60° F. It is therefore apparent that atmospheric temperature conditions do not have to be particularly severe before difficulties may be encountered.

For the above reasons it has been necessary to provide for dehydrating natural gas to reduce the dew point before sending the gas through long high pressure transmission lines which are subjected to low atmospheric temperatures. Dehydration to a dew point below the minimum temperature to which the line will be subjected in the territory through which it passes has the following advantages:

(1). Maintenance at all times of full line capacity which would otherwise be reduced due to the formation of hydrates and water condensate. (2). Elimination of the necessity of blowing the drips to remove condensate. (3). Elimination of regulator freeze-ups. (4). Reduction of internal corrosion of the pipe line.

Natural gas dehydration is generally accomplished by contacting the gas with an hygroscopic liquid. Refrigerated calcium chloride water solutions have been used for this purpose. The cycle of operation when using diethylene glycol is basically the same as for brine. Dew point depressions up to 60° F. can be secured with concentrated diethylene glycol without refrigeration, which is necessary when correspondingly low depressions are to be secured with brine solutions. Refrigeration equipment materially increases plant investment. Diethylene glycol is not corrosive, and has a low freezing point so there is no possibility of solidification of the solution in the system. During 1937 six commercial plants were installed employing diethylene glycol for dehydrating natural gas.

Properties of Diethylene Glycol

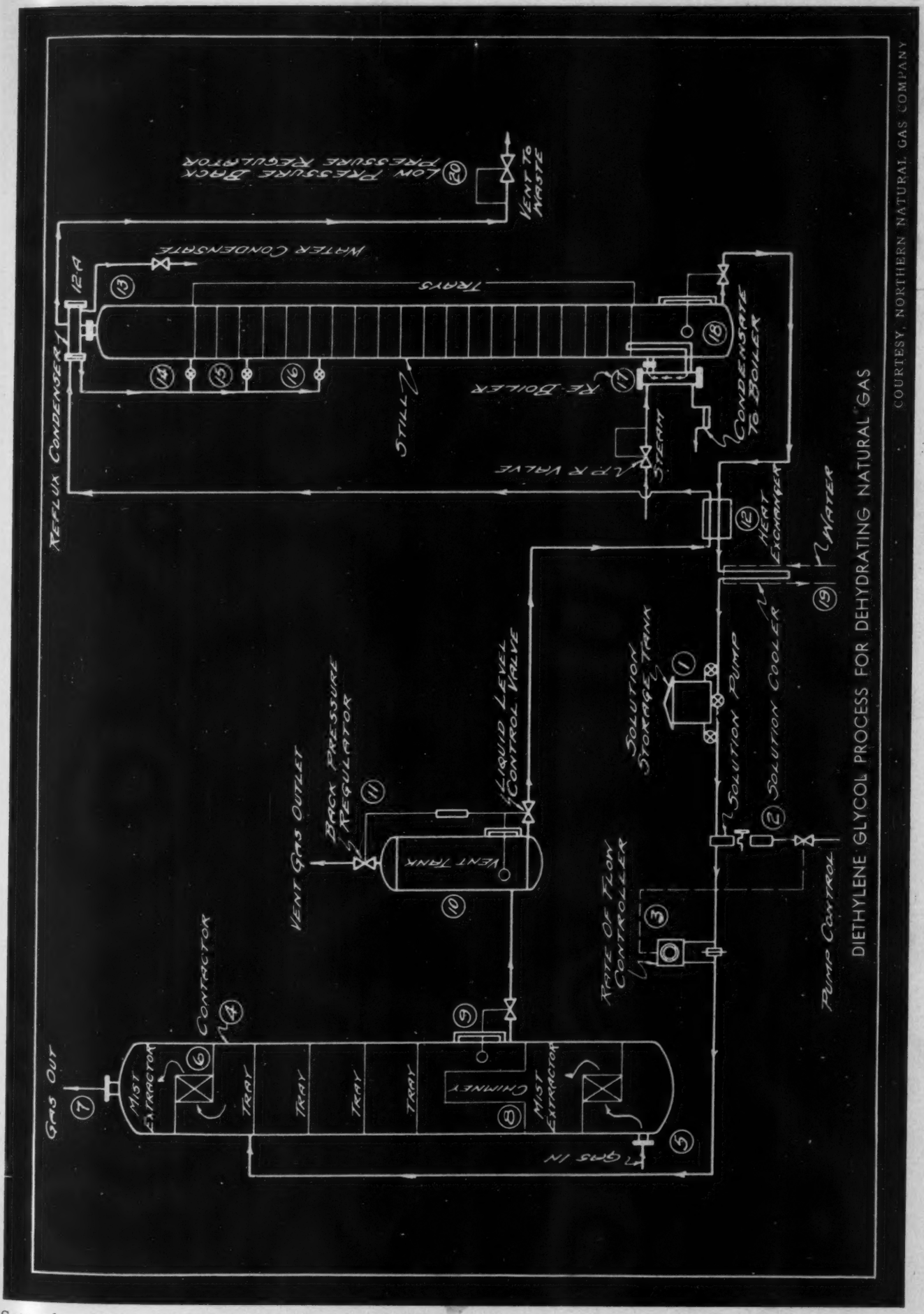
Formula	$HOCH_2CH_2OCH_2CH_2OH$
Molecular Weight	106.08
Boiling Point	244.5°C. (472.1°F.)
Freezing Point	—6.5°C.
Specific Gravity	1.1185 20/20°C.
Weight Per Gallon	9.308 lb. 20°C.
Viscosity	0.38 poises 20°C.
Vapor Pressure	0.015 mm. Hg 20°C.
Specific Heat	0.5509 20°C.
Latent Heat of Evaporation	150 cal./g. at B. P.
Coefficient of Expansion(per °C.)	0.000635 at 20°C.
	0.000650 at 55°C.

Operation of the plant, as shown in the flow diagram on the opposite page, is as follows: Cooled diethylene glycol containing a small amount (generally less than 10 percent) of water depending on the final dew point desired is picked up from the solution storage tank (1) by a pump (2) capable of pumping against the pressure at which the gas is to be treated. The solution flows through a flow controller (3) which controls the speed of the pump and into the top of the tray type contactor (4). Gas enters the bottom of the contactor through a mist extractor to remove mineral seal oil, etc. The contactor is equipped with bubble cap trays, the solution descending counter-current to the ascending natural gas. The gas leaves the contactor through mist extractor (6) and outlet connection (7) into the transmission line. The solution which has absorbed water from the gas is collected on the chimney plate (8). The liquid level on the chimney plate is controlled by the flow controller (9) and flows into a vent tank (10) provided with a back pressure regulator (11) which maintains sufficient pressure in the vent tank to force the liquid through the heat exchangers (12) and the reflux condenser (12-A) into the top of the still (13). Natural gas released in (10) is vented through the vent gas outlet.

Glycol solution passes through the reflux condenser (12-A) into the still through valves 14, 15 or 16 as desired, generally through one of the lower openings. The solution flows down over bubble cap trays in the still column and into the lower portion of the re-boiler (17) where it is heated by closed steam coils and is returned to the kettle (18) in the lower part of the still. Water remaining in the heated solution is vaporized in the kettle and passes through the bubble cap trays of the still column. This serves to heat the descending solution and separates the diethylene glycol from the water vapor, thus eliminating loss of diethylene glycol in the still. Any natural gas or uncondensed water vapor in the reflux condenser (12-A) are vented through the back pressure valve (20). Excess condensate in the reflux condenser is drained through the condensate line to the sewer. The solution in the kettle (18) having been substantially denuded of water passes through the heat exchangers (12) in counter-current relation to the weak solution from the vent tank, and thence through a cooler (19) to storage tank (1). Replacement solution is added to the system when necessary, at this point. The cycle of operation described is continuous.

In one commercial plant which treated 12,250,000,000 cubic feet of natural gas in an eleven month operating period, the total over-all loss of diethylene glycol averaged .0517 gallons per million cubic feet measured at 16.4 pounds per square inch absolute pressure.

Diethylene glycol is manufactured by the Carbide and Carbon Chemicals Corporation, 30 East 42nd Street, New York, N. Y.


DIETHYLENE GLYCOL PROCESS FOR DEHYDRATING NATURAL GAS
COURTESY, NORTHERN NATURAL GAS COMPANY
REFLUX CONDENSER
12A
WATER CONDENSATE
LOW PRESSURE BACK PRESSURE REGULATOR
VENT TO WASTE
TRAYS
STILL
RE-BOILER
CONDENSATE TO BOILER
LP R VALVE
STEAM
HEAT EXCHANGER
WATER
SOLUTION STORAGE TANK
SOLUTION PUMP
SOLUTION COOLER
LIQUID LEVEL CONTROL VALVE
BACK PRESSURE REGULATOR
VENT GAS OUTLET
VENT TANK
RATE OF FLOW CONTROLLER
PUMP CONTROL
CONTACTOR
GAS OUT
MIST EXTRACTOR
TRAY
TRAY
TRAY
TRAY
CHIMNEY
MIST EXTRACTOR
GAS IN

Girbotol Purification Process

THE Girbotol Process (patented) for the separation of acidic constituents from gaseous mixtures is widely used for the purification of gases in the petroleum industry. The process is being employed for the removal and recovery of hydrogen sulphide from natural and refinery gases, for the simultaneous desulphurization and dehydration of natural gas, and for the separation of carbon dioxide from hydrogen used for hydrogenation of oil and synthesis of isooctane. This information is presented through the cooperation of The Girdler Corporation, Louisville, Kentucky.

Operation of the Girbotol Process is based upon the discovery that aliphatic amines have a strong affinity for acid gases such as hydrogen sulphide and carbon dioxide at or near atmospheric temperature, but at higher temperatures the affinity drops off rapidly and the gas is expelled. The process operates in a continuous cycle, absorbing acid gas from a gas stream at atmospheric temperature and expelling it at another point by raising the temperature of the absorbent. Because the amines are strong bases, freely soluble in water, large volumes of acid gas may be removed per volume of solution circulated. The efficiency of the process is therefore high. Hydrogen sulphide is recovered in concentrated form.

The cycle and equipment employed in the process are almost identical with those of a gasoline absorption plant (see flow chart). Gas to be treated flows up through a bubble tower or absorber. Amine solution, at atmospheric temperature, enters the absorber and flows down the tower from tray to tray picking up the acid gas. Purified gas leaves the absorber at the top.

Amine solution, saturated with acid gas, passes through heat exchangers, where its temperature is raised to 190-200° F., and into the upper part of the reactivator, which also consists of a bubble tower, containing in its base a tubular reboiler section and at the top a reflux condenser. The amine solution, flowing down the tower, is heated to 215-220° F. by steam rising from the boiling solution in the reboiler section, and the acid gas is expelled and flushed out by ascending vapors. The acid gas leaves the reactivator saturated with water vapor at 190-200° F. and flows through the condenser where it is cooled by water and the steam condensed. The condensate is returned to the reactivator. Hot, lean solution, stripped of acid gas flows from the base of the reactivator to a pump, thence through the exchangers in counter current relation to the cold, rich solution. From the exchangers the solution passes through water coolers, and finally back to the top of the absorber. The plant is entirely automatic in operation, requiring only casual supervision.

Desulphurization—Separation of hydrogen sulphide from hydrocarbon gases is accomplished as described above. The gases may be treated at high or low pressure with equal success, but gas under pressure is purified more economically because smaller towers are required and larger volumes of hydrogen sulphide are removed per gallon of solution circulated. The process is well adapted for purifying gas containing a high percentage of hydrogen sulphide. The rate of reaction in the absorption stage is so rapid that complete stripping may be obtained in a single tower. Because an aqueous absorbing solution is employed, practically no hydrocarbon constituents are removed from the gas if the physical conditions of temperature and pressure are controlled. This makes it possible to apply the process for the purification of wet gas before the extraction of gasoline and results in lower subsequent treating costs to purify the gasoline.

The Girbotol Process is useful for the purification of gaseous feed to a polymerization plant. Unless the poly feed is substantially free of hydrogen sulphide, mercaptans and other sulfur compounds formed during polymerization must be removed from the poly product. Such after-treatment is expensive and damaging to the octane number and the blending value of the poly product. The poly feed may be purified with the Girbotol Process at any temperatures up to 180° F.

Dehydration and Desulphurization—In several Girbotol plants purifying natural gas for pipe line distribution, simultaneous dehydration of the gas is accomplished by employing a dehydrating liquid such as diethylene glycol in solution with the Girbotol absorbent. H_2S and water are both scrubbed from the gas, and expelled together from the Girbotol reactivator, the H_2S assisting in carrying the excess water from the tower.

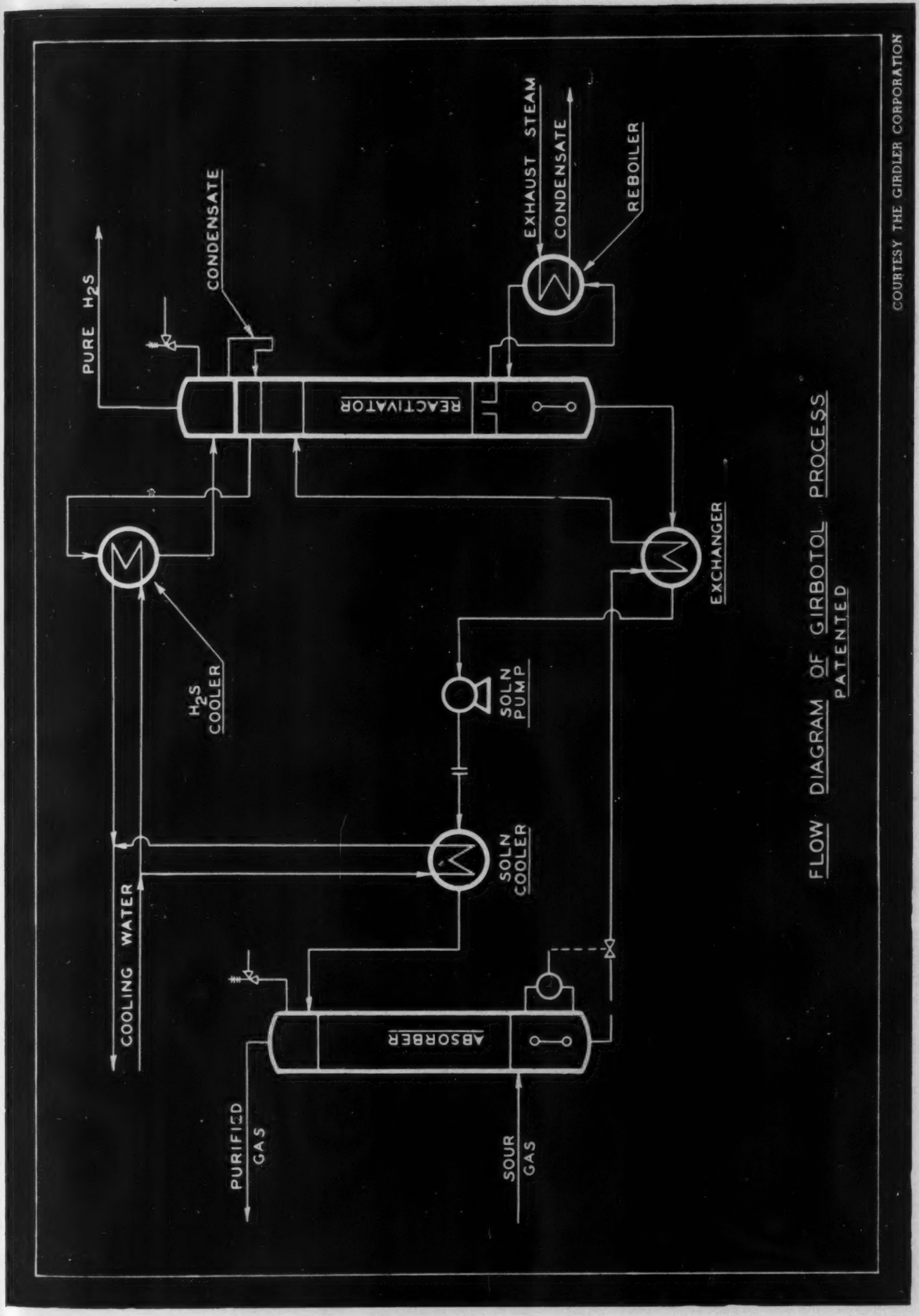
It is thus possible to sweeten sour natural gas and dry it in a single, simple plant. Such gas is being distributed through pipe lines to domestic and industrial customers, without troubles from pipe line freeze-ups.

Carbon Dioxide Removal from Hydrogen—Large volumes of industrial hydrogen are now prepared by reacting methane with steam at a high temperature and oxidizing the resulting carbon monoxide to carbon dioxide with an additional quantity of steam at a lower temperature. The reactions are

$$\begin{aligned} CH_4 + H_2O &\rightarrow CO + 3H_2 \\ CO + H_2O &\rightarrow CO_2 + H_2 \\ \hline CH_4 + 2H_2O &\rightarrow CO_2 + 4H_2 \end{aligned}$$

The resulting gas mixture contains 18-20 percent carbon dioxide and practically no carbon monoxide.

The Girbotol process will separate carbon dioxide from such a mixture economically. Separation with amine solution may be carried out at relatively low pressures, whereas good efficiency with water is obtained only at high pressures. Even though the hydrogen must be subsequently compressed further, there is a saving in compression cost if the carbon dioxide is removed at an intermediate pressure. With the Girbotol process the carbon dioxide may be completely eliminated with relatively small volumes of absorbing solution, while very large volumes of water must be employed for comparable purification. Before use, the water must be decarbonated and deaerated.


FLOW DIAGRAM OF GIRBOTOL PROCESS
PATENTED
COURTESY THE GIRDLER CORPORATION
PURE H_2S
CONDENSATE
REACTIVATOR
EXHAUST STEAM
CONDENSATE
REBOILER
EXCHANGER
H_2S COOLER
SOLN PUMP
SOLN COOLER
COOLING WATER
ABSORBER
PURIFIED GAS
SOUR GAS

I. G. Alkacid Process

GAS PURIFICATION

I. G. FARBENINDUSTRIE A. G., Ludgwigshafen am Rhein, Germany, has developed the I. G. Alkacid process for gas purification which is being used abroad in several countries. In the Alkacid process strong inorganic bases with weak organic non-volatile acids, such as aminosulfoacids and amino-carbonicacids are used as the absorption agents. Three solutions have been developed to meet various requirements.

These solutions, which differ in their absorptive capacity for hydrogen sulfide and carbon dioxide are known as Alkacid solutions "M," "Dik," and "S"; and are used in accordance with the required removal of impurities. Solution "M" is used for removal of either gas, when present alone, or for the removal of both gases simultaneously. Solution "Dik" is used for selective removal of hydrogen sulfide from gases containing carbon dioxide, and also from gases containing small quantities of carbon disulfide and hydrocyanic acid. Solution "S" is used for the same purpose as either solution "M" or "Dik" when the gas contains an appreciable amount of other impurities, such as hydrocyanic acid, ammonia, carbon disulfide, mercaptans, dust and tar.

The general scheme of this process is very simple. The equipment consists essentially of a scrubbing tower, a stripping column, a heat exchanger and cooler. The gas to be purified is scrubbed in the absorber tower countercurrently with cold reactivated Alkacid solution, which absorbs the hydrogen sulfide and carbon dioxide from the gas, and collects in the lower section of the tower as a saturated solution. The solution is then pumped through a heat exchanger, in which it is heated to 175 to 195° F. and then enters the top of the reactivating tower. The gas is stripped of its absorbed constituents by steam generated by a reboiler, and the hot reactivated solution is withdrawn from the bottom of the tower, cooled to 105 to 122° F. by heat exchange with the used solution from the absorber tower. The solution, after further cooling in a water cooler enters the top of the scrubbing tower. The process is continuous, and the only utility requirements are steam, water and power.

The Alkacid solutions are relatively non-corrosive, and the equipment requires no special materials of construction with the exception of a few parts which are particularly subjected to wear.

After condensing the steam, the carbon dioxide and hydrogen sulfide content liberated from the reactivator are available for any desired purpose. For the removal of both carbon dioxide and hydrogen sulfide from a gas without separate recovery, a single scrubbing tower can be used, provided that sufficient time of contact for the removal of the carbon dioxide is obtained. If hydrogen sulfide alone is to be removed from the gas containing carbon dioxide, Alkacid solution "Dik" should be used, allowing a short time of contact in the absorber tower. For the removal of both gases and for separate recovery they can be removed separately or they can be scrubbed out together, and then the hydrogen sulfide removed from the carbon monoxide by means of the selective solution "Dik." Figure I, is the flow diagram of the process in use for the purification of gases.

The hydrogen sulfide released by the Alkacid process can be converted into free sulfur by combustion with air. The I. G. Claus process has recently been improved by its owners, with improvements including a new catalyst and a steam boiler is employed for the more efficient removal of heat. Figure 2 is the flow diagram of the process and the equipment consists of an apparatus for removing heat, such as a boiler, a Claus oven, and a sulfur separator, all of which is connected to an Alkacid gas purification plant. The gases from the Alkacid plant are burned with the necessary amount of air in the boiler to which the heat evolved is released. The gases at 480 to 575° F. are passed over the catalyst, and the final conversion takes place; sulfur separates out in liquid form partly in the sump of the oven and partly in the centrifugal separator.

A 92 to 94 percent yield is obtained, based on the hydrogen sulfide fed to the plant. The hydrogen sulfide and sulfur dioxide remaining in the gas can be completely converted to sulfur with water or aqueous salt solutions. The hydrogen sulfide can also be catalytically converted into sulfur dioxide with air, and the sulfur dioxide may be further processed to sulfuric acid.

The application of the Alkacid process has grown considerably since its development. At present around 150,000,000 cubic feet per day of gases are being purified by this process in Germany, and approximately 1,000,000 cubic feet per day of hydrogen sulfide are separated. Several plants are in operation for various purposes and 12 plants are under construction at present. Close to 30,000 metric tons per year of sulfur are obtained from the operation of the Alkacid process in Germany, and this represents more than half of the German sulfur production. This indicates the importance of the technical development of this type of process.

The foregoing is based on a paper "Gas Purification by the I. G. Alkacid Process and Sulfur Recovery by the I. G. Claus Process," by Hans Baehr, presented before the Division of Refining, American Petroleum Institute, May 24, 1938, and the complete paper appears in The Refiner, Volume 17, No. 6, June, 1938, page 237.

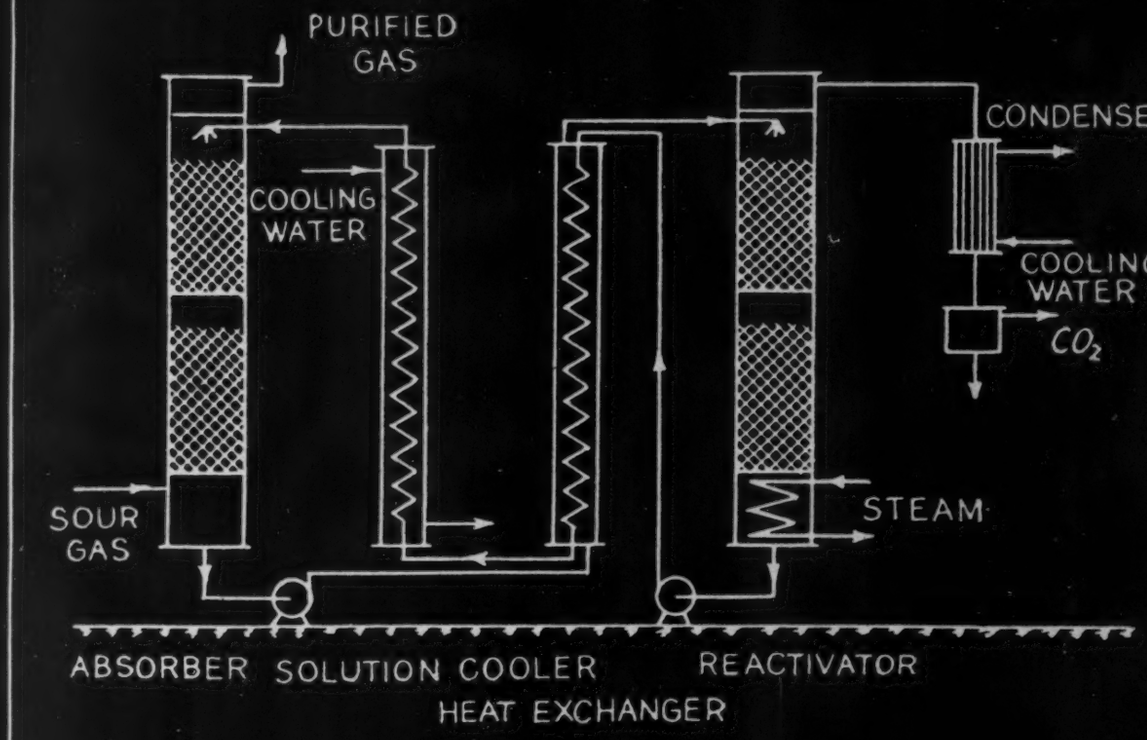


Figure 1—I. G. Alkacid Process for Purification of Gases

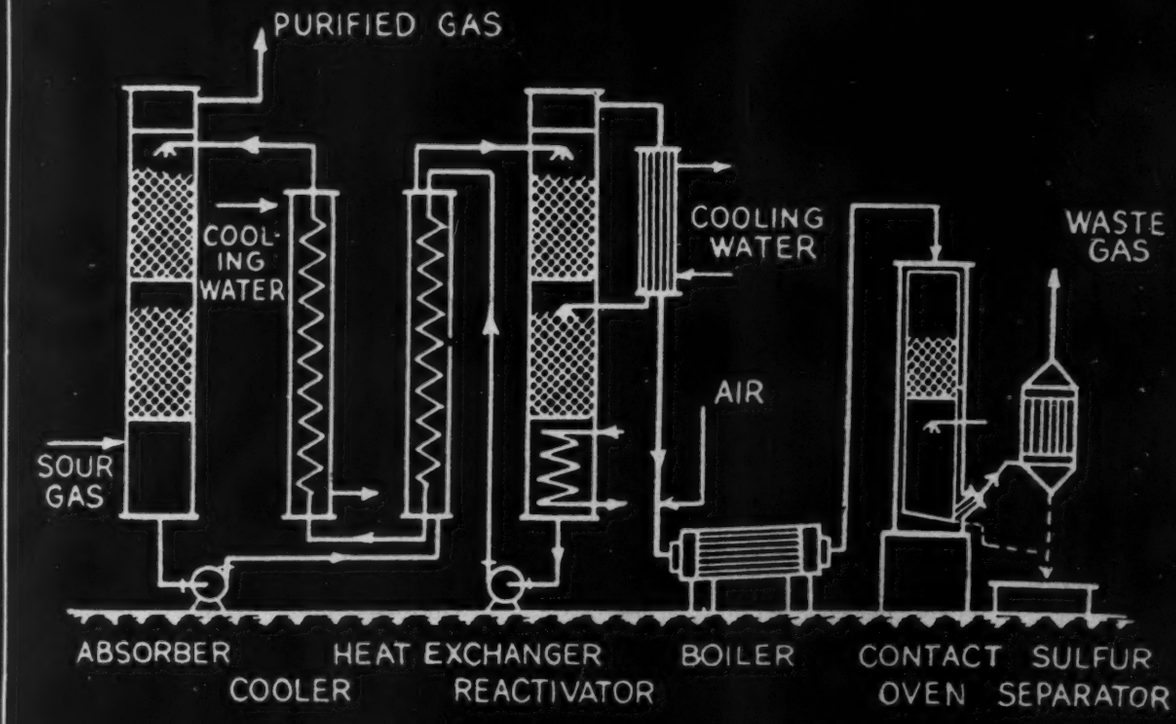


Figure 2—Alkacid Process for Purification of Gases and Recovery of Hydrogen Sulfide as Free Sulfur

I. G. ALKACID PROCESS

Phenolate Gas Purification Process

THE Koppers Company pioneered in the field of gas purification by means of liquids with the introduction of the Seaboard process 15 years ago, and, since that time, has prosecuted a continuous program of research directed toward the development of improved processes for the treatment of various types of gases. More than 90 plants have been built in all parts of the world to utilize these processes for the removal of hydrogen sulfide from coal gas, water gas, natural gas, refinery-still gas, and various gases in chemical plants.

Recently developed processes for the synthesis of valuable motor fuels and chemicals from refinery-still gas are, in many cases, applicable only to gases low in hydrogen sulfide. The Phenolate Gas-Purification process was developed for the particular purpose of purifying refinery-still gas and natural gas, with the profitable production of substantially pure hydrogen sulfide. Since hydrogen sulfide frequently occurs in these gases in high concentrations, sulfur may be recovered from them by the Phenolate process at a cost which is considerably less than that of natural brimstone at its source. In addition to the production of low cost sulfur, the gas is purified to the extent of 95 to 99.8 percent. Purified gas may be distributed for domestic use or it may be treated for conversion to liquid hydrocarbons by pyrolysis and polymerization.

Sulfur recovered by the Phenolate process is in a form readily adaptable to the manufacture of sulfuric acid by any of the conventional methods. It frequently happens that there is sufficient sulfur in the cracking-still gas now being burned under boilers to supply the acid requirements of the entire refinery, and at a total cost which may be as low as 50 percent of contract acid cost. Present day acid plants used for converting hydrogen sulfide gas into sulfuric acid are simple, compact units which are practically automatic in their operation. They require no special type of labor and supervision other than the usual refinery personnel.

The purification system consists of an absorption stage and an actification stage, through which the Phenolate solution is circulated continuously. This solution has an extremely high carrying capacity for hydrogen sulfide, and as a result, it is necessary to circulate only five to 10 gallons of solution per thousand cubic feet of sour gas. This very low circulation rate is one of the reasons for the low operating expense and the small size of equipment required in comparison to other liquid purification processes.

Referring to the single stage flow diagram, the hydrogen-sulfide laden gas enters the absorber at the base, passes up through the bubble-cap trays and leaves at the top, stripped of 95 percent of its hydrogen sulfide. The solution leaving the bottom of the absorber, saturated with hydrogen sulfide with respect to the incoming gas, passes through the heat-exchanger tubes to the top tray of the actifier. It flows down over the actifier trays, counter-currently to the stripping steam which is generated in the reboiler at the base. Sufficient indirect steam is used to effect the desired degree of actification of the solution. This, in turn, is determined by the maximum residual hydrogen sulfide desired in the exit gas.

The actified solution flows from the reboiler through the heat-exchanger shell, is further cooled in the solution cooler, and is then pumped to the fourth tray below the top of the absorber. The absorption cycle starts again at this point.

Hydrogen-sulfide laden steam passes from the top of the actifier to the dephlegmator shell and thence the hydrogen sulfide is forced, by the actifier pressure, to the acid plant burner or other point of disposal. Condensate from the dephlegmator returns to the actifying column.

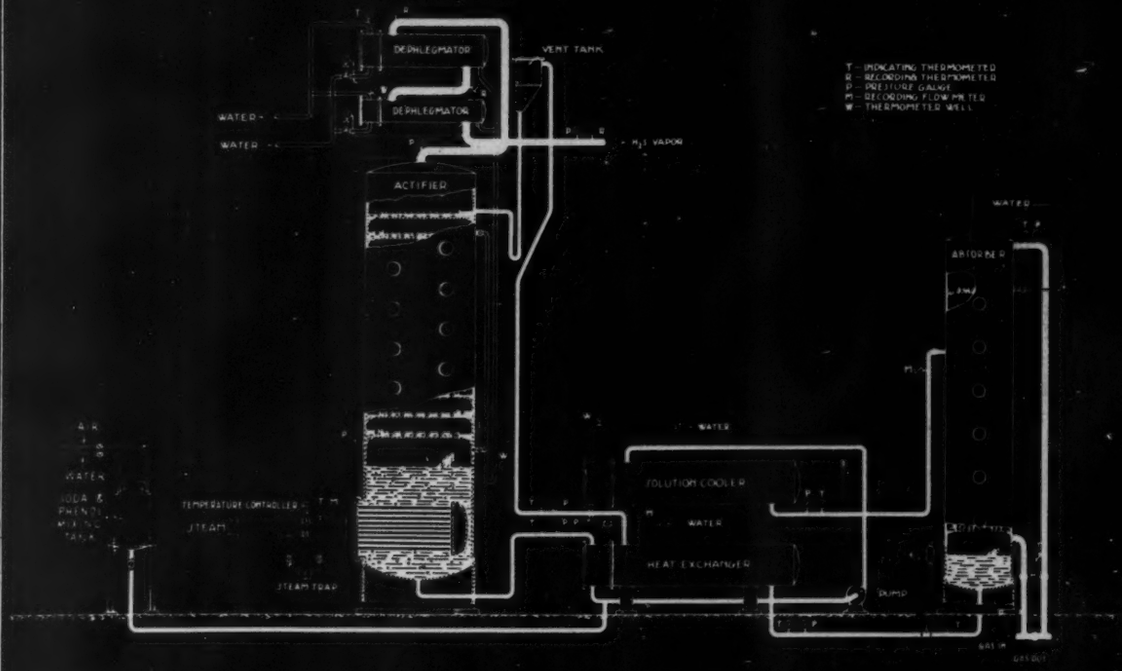
Fresh water is added continuously to the top tray of the absorber. The three top trays comprise, in effect, a water scrubber to recover chemicals which have been entrained or evaporated from the solution. It is necessary, at periods of several days, to replenish chemicals lost from the system, and a small mixing tank is provided for this purpose. The caustic soda and crude phenol used in the process are inexpensive.

The Koppers two-stage Phenolate Process has been developed to effect maximum steam economy in instances where large quantities of sulfur are to be removed and where the steam or other heat consumption is a vital item in the operating expense. The two-stage process is recommended also in cases where virtually complete removal of hydrogen sulfide is required. The operation of the two-stage system differs from the single-stage operation as outlined above, in the following particulars:

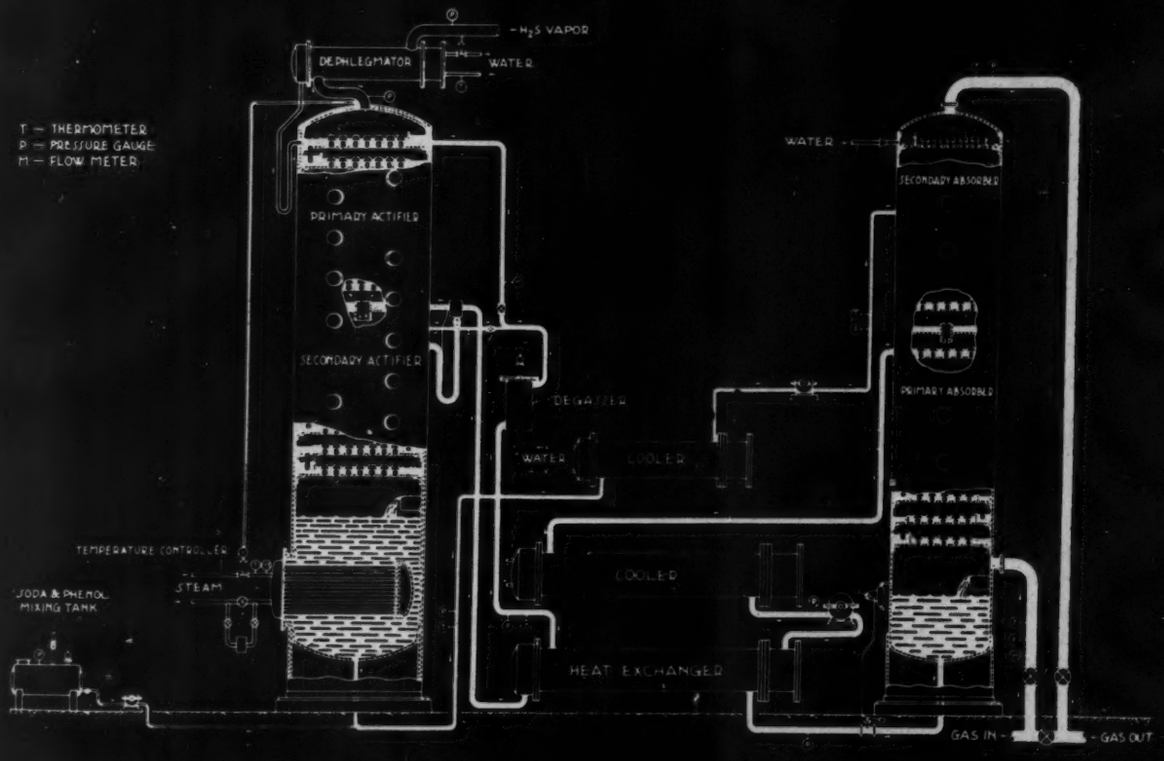
The major portion of the solution is withdrawn from the actifier about mid-way of the column and is introduced into the absorber about halfway down the column after passing through the heat exchanger and cooler. The minor portion of the solution continues down to the base of the actifier and in the course of this travel is contacted with a proportionately large amount of fairly clean steam. This small volume of highly actified solution is pumped through a cooler to the upper section of the absorber. After flowing through the secondary absorber, this solution joins the main body of solution in the primary absorber and the entire volume of solution is forced by gas pressure through the heat exchanger to the top of the actifier column.

Koppers Phenolate Process plants now in operation for purification of refinery and natural gases have an aggregate daily treating capacity of 55,000,000 cu. ft. of gas recovering annually 26,000 tons of sulfur which is equivalent to 75,000 tons of 66° Bé. sulfuric acid. Two of the larger refineries in the country have installed this equipment to convert sulfur in the still gases to sulfuric acid, thus eliminating a serious nuisance while recovering a valuable by-product.

Patents covering the Phenolate Process are U. S. 1,971,798; 2,002,357; 2,028,124; and 2,028,125. This description is presented here through the cooperation of the Engineering and Construction Division of Koppers Company, Koppers Building, Pittsburgh, Pennsylvania.



SINGLE STAGE FLOW DIAGRAM



TWO STAGE FLOW DIAGRAM

KOPPERS LIQUID PURIFICATION SYSTEMS
FOR NATURAL AND REFINERY STILL GASES—PHENOLATE PROCESS

COURTESY, ENGINEERING AND CONSTRUCTION DIVISION, KOPPERS COMPANY

Shell Phosphate Process

GAS PURIFICATION

THE Shell Phosphate Process, developed by the Shell Development Company, San Francisco, California is a regenerative liquid-purification system for the removal and recovery of hydrogen sulfide from natural or refinery gases and liquid hydrocarbons.

The gas to be purified is scrubbed in a bubble plate or packed absorber with an aqueous solution of tripotassium phosphate. Hydrogen sulfide is absorbed. The reaction is reversed by boiling the solution. The vapor boiled off (hydrogen sulfide and steam) is condensed and cooled; the condensate is returned to the absorber, and the hydrogen sulfide is vented to suitable disposal; e.g., boiler fuel or surfuric acid manufacture, sulfur recovery, process use, etc. Regeneration is usually accomplished in a standard reboiler with exhaust steam, or in some cases a direct-fired regenerator may be used. Heat economy is realized through use of exchangers on the solution to and from the regenerator. A final cooler lowers temperature of the lean solution returned to the absorber.

The solution used runs from 40 to 50 percent by weight of tripotassium phosphate and this inexpensive solution is prepared at the plant with commercial grades of potassium hydroxide and of tripotassium phosphate. The initial charge lasts indefinitely, as solution loss is confined to packing-gland leakage on pumps.

The equilibrium vapor pressure of hydrogen sulfide over tripotassium phosphate solution for a given hydrogen sulfide saturation is greatly reduced upon diluting the solution with water. This reduction in vapor pressure with reduced tripotassium phosphate concentration is peculiar to the phosphate process, and advantage is taken of this fact by using a system of split solution flow in the absorber. The bulk of the hydrogen sulfide is absorbed in the lower section of the absorber with a 40 to 50 percent solution, while the more difficult absorption at lower hydrogen sulfide concentration is accomplished in the upper section with a relatively dilute solution.

The system of absorbing hydrogen sulfide with solutions of different concentrations makes it unnecessary to regenerate all of the solution to the lower degree of hydrogen sulfide saturation required for a low hydrogen sulfide content in the treated gas. The dilute solution is obtained by returning the condensate from the regenerator accumulator to the top of the absorber along with a small amount of the regenerated solution. The greater portion of the regenerated solution is returned to the lower section of the absorber.

For many installations the phosphate process may be used economically for treating gases at temperatures up to 200° F. This is often an advantage in purifying the gases supplied to polymerization plants.

Liquid hydrocarbons may be treated for removal of hydrogen sulfide with this process since the tripotassium phosphate solutions are immiscible with hydrocarbons. Only one of two stages are necessary, depending upon the degree of purification required. The regeneration system is the same as that used for vapor phase treating, and may be either the steam or direct fired type. In liquid phase as in vapor phase treating, two-solution concentrations may be employed to advantage in a two-stage treatment.

The process is economical. It is practically noncorrosive to iron and steel equipment. Copper or copper-bearing materials should not be used. The tripotassium phosphate is relatively inexpensive. The process does not introduce catalyst poisons to the gas or liquid hydrocarbons treated for polymerization or other processing. It is a self-operating process requiring a minimum of regulation and control tests. The tripotassium phosphate is a very stable salt and does not break down or decompose through complex side reactions in this service. The plant is simple to construct and requires a minimum amount of standard equipment, and the maintenance cost is low. The process is covered by U. S. Patents 1,945,163 and 2,110,403, assigned to the Shell Development Company and other patents are pending. Several such plants are now in successful commercial operation.

The foregoing description is based on a paper "The Shell Phosphate Process for the Removal of Hydrogen Sulfide," by T. W. Rosebaugh, Shell Development Company, presented before the Division of Refining, American Petroleum Institute, May 24, 1938, and the complete paper with detailed description of the process appeared in The Refiner, Volume 17, No. 6, June, 1938, page 245. The flow diagrams appearing on the opposite page have to do only with the Shell Phosphate Process for removal of hydrogen sulfide from natural or refinery gas (Figure 1) and the same process used for removal of hydrogen sulfide from liquid hydrocarbons (Figure 2). In the reference cited above will be found flow diagrams for this system when employed for hydrogen sulfide removal for very high degree of purification for liquid or vapor phase treating, and for hydrogen sulfide removal using a direct fired regenerator, for liquid or or vapor phase treating.

KEY TO FIGURE 1

1. Boiler-type regenerator.
2. Exchanger.
3. Exchanger.
4. Condenser.
5. Solution Cooler.
6. Condensate Accumulator.
7. Condensate Pump.
8. Solution Pump.

KEY TO FIGURE 2

1. Reboiler-type regenerator.
2. Exchanger.
3. Exchanger.
4. Condenser.
5. Solution Cooler.
6. Condensate Accumulator.
7. Condensate Pump.
8. Solution Pump.
9. Circulation Pumps.
10. Stage Transfer Pump.
11. Phase Separator.

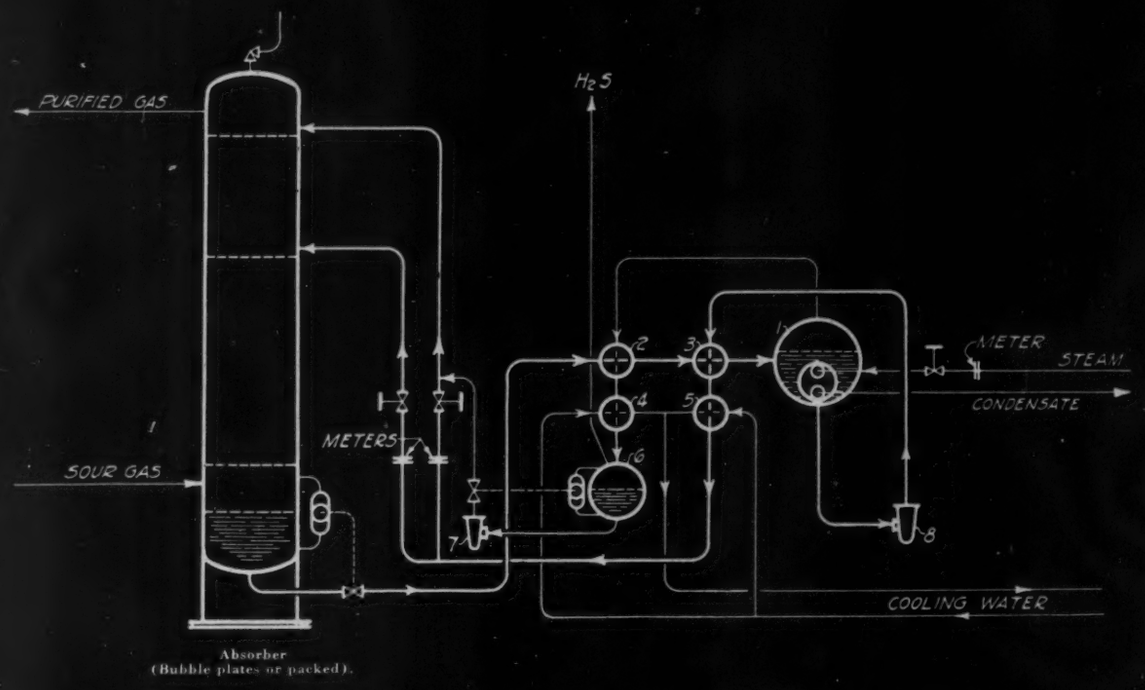


Figure 1—Shell Phosphate Process for Removal of Hydrogen Sulfide from Gases

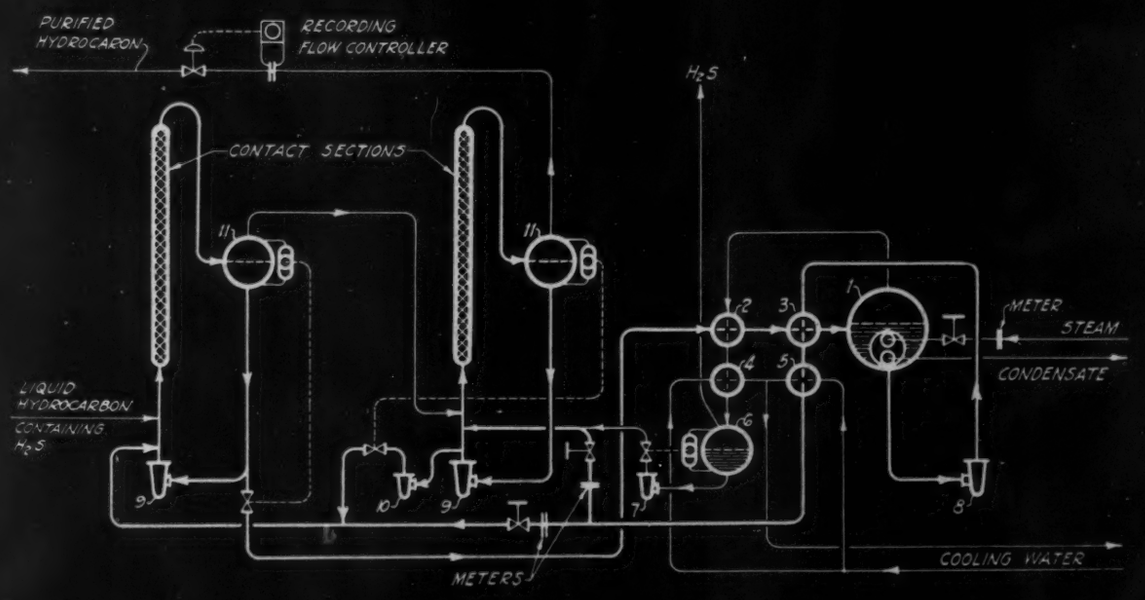


Figure 2—Shell Phosphate Process for Removal of Hydrogen Sulfide from Liquids

SHELL PHOSPHATE PROCESS

Absorption Oil Refrigerating System

SINCE weather conditions in many sections of the country are of such character that atmospheric cooling can not be carried sufficiently low to obtain best efficiency, outside means are being employed to create lower temperatures. A typical application of absorption oil refrigeration, adapted to a gasoline plant which has been in operation for some time, is that of the Fittstown, Oklahoma, plant of J. E. Crosbie, Inc., where difficulties were encountered in recovering all available gasoline fractions when operating at natural, normal temperatures obtained with cooling water. Investigation of the older types of gasoline plant refrigeration and of the modern methods of temperature reduction in refineries was responsible for the process now employed.

The completed refrigeration unit, as it now stands, is the result of experimenting. The first series or section of heat exchangers installed had a total of 2052 square feet of exchanger surface, which proved insufficient to secure the desired absorption oil temperature. Therefore, two additional series of exchangers were installed, one group totaling 1830 square feet and the second group having 2808 square feet of exchanger surface. Engines in the compressor room were fitted with 13½ inch compression cylinders, using both sides of one twin engine and one side of a second engine, which was sufficient capacity to handle the 3,000,000 cubic feet of combined propane-butane vapors daily.

The absorption oil, pumped through the usual type of atmospheric cooling sections is reduced in temperature to an average of about 95° F., depending on weather conditions. The flow is then through the two groups of exchangers mentioned above, and in parallel. As the split stream leaves these two sections it is joined and flows through the third section of exchangers with 2052 square feet of surface. The object in splitting the flow in this manner is to obtain first shock cooling in the parallel units and completing the temperature reduction in the third group of exchangers. This practice secures a reduction of absorption oil temperature of about 35°F., or an absorber inlet temperature of about 60°F. The flow sheet on the opposite page gives details of this type of hook up. Several arrangements may be used for outside refrigeration systems, and new plants now going in are often designed for refrigeration of absorption oil inside of the absorbers. Some of these systems are described in a special article in this issue of The Refiner.

Refrigeration material available in this plant is a rough cut from the plant stabilizer which consists of a varying mixture of propane and butane, depending upon the grade of gasoline being produced. Pressures around 125 pounds discharge are required to liquefy the refrigerant which is carried in a closed circuit. The intake on the compressors ranges from 5 to 7 pounds gauge.

Flooded exchanger surface is maintained while reducing temperature of the absorption oil through the use of a receiver, or volume drum placed above each section of the coolers. These drums are equipped with liquid level controls, which operate controlled valves in the propane-butane supply lines leading from the accumulator drum to the lower side of each group of exchangers. The exchanger sections are stacked in the customary manner with conventional oil connections, but they have refrigeration liquid connections placed at several points on the lower side to secure equal distribution without dry pockets. The outer side of each bank of exchangers is equipped with a 6 inch relief line to insure unobstructed flow of vapors from section to section and to the volume drum above the exchangers.

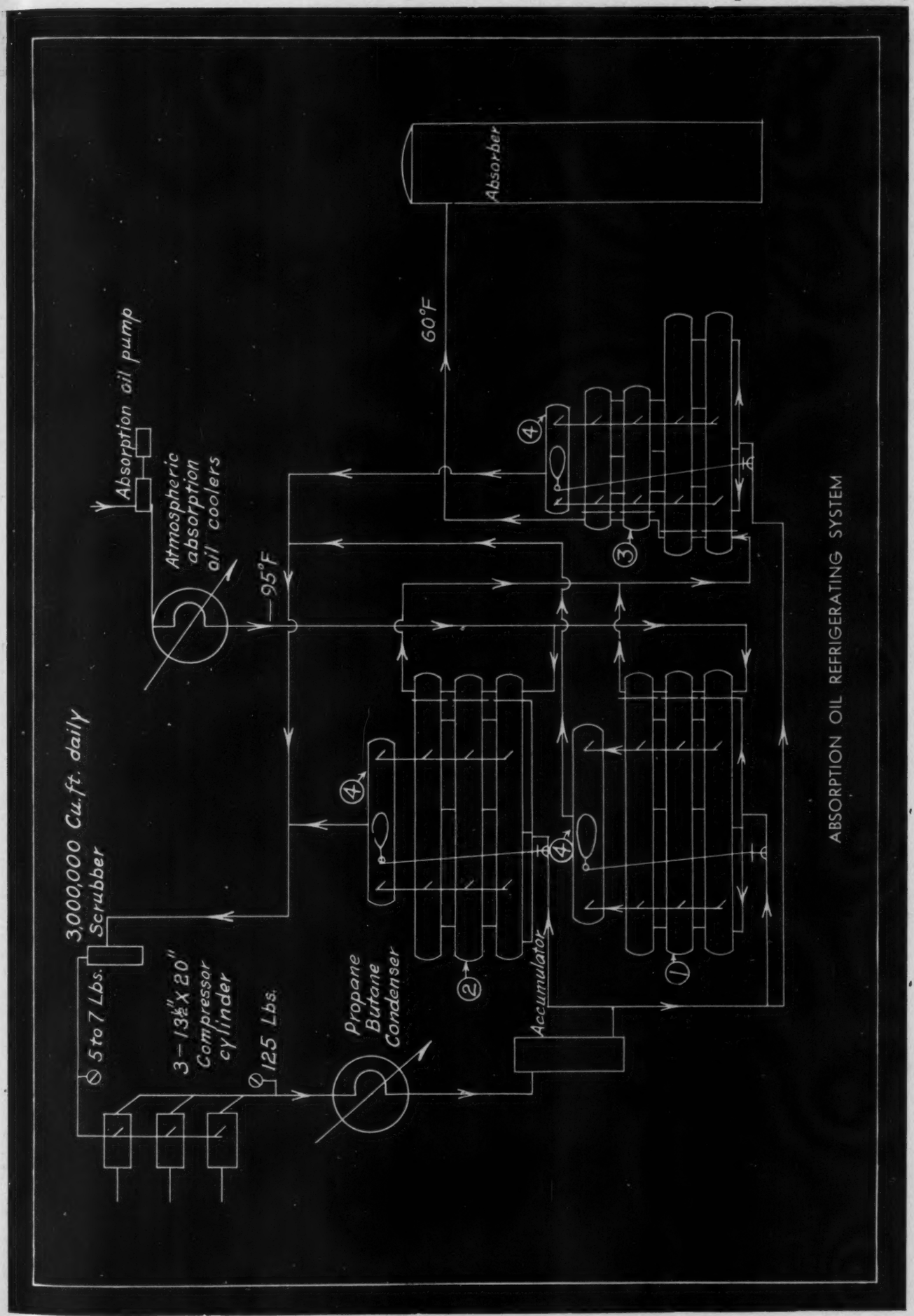
A common suction line which carries vapors from each of the three volume drums is led through a liquid scrubber to protect compressor cylinders, with pressures averaging from 5 to 7 pounds gauge. The vapors are compressed to about 125 pounds, cooled, and liquefied in atmospheric sections and accumulated in a common receiver from which a main line leads to distribution at the chillers.

Since the plant is not equipped with a secondary stabilizer to fractionate a relatively pure butane cut for refrigeration, and the rough overhead is used, this product contains relatively small amounts of heavier hydrocarbons which are not liquefied as readily as the lower boiler fractions. At intervals the refrigeration system is purged by venting the liquid to the stabilizer charging pumps to recover the heavier fraction. A fresh charge of propane-butane is then placed in the refrigeration system which is satisfactory for several months operation.

The efficiency of this unit has been definitely proven by diverting absorption oil from atmospheric coolers to the absorbers without chilling. With all other conditions remaining normal, such as volume of gas, circulation of definite volumes of oil over the absorbers, it is found that plant efficiency is improved about 20 percent through the use of the refrigeration system.

KEY TO DRAWING

1—Six, 10 inch chillers, 1830 sq. ft.
2—Six, 12 inch chillers, 2808 sq. ft.
3—Four, 10 inch and twelve 10 inch by 5 feet chillers, 2052 sq. ft.
4—Vapor tanks above chillers equipped with liquid level controls.


ABSORPTION OIL REFRIGERATING SYSTEM
Absorber
60°F
Absorption oil pump
Atmospheric absorption oil coolers
95°F
3,000,000 Cu.ft. daily
Scrubber
5 to 7 Lbs.
3 - 13½" X 20"
Compressor cylinder
125 Lbs.
Propane Butane Condenser
Accumulator
1
2
3
4

Pressure Maintenance Process

GASOLINE RECOVERY

PRESSURE maintenance is defined as the practice of returning gas which has been passed through a compression plant and which has had its gasoline content extracted, to the oil-producing formation for the purpose of maintaining reservoir pressure and energy and the value of this practice has been proved during recent years. The industry will see a large number of these plants installed and gasoline from so-called distillate wells will be economically produced while the practice will serve to save gas for fuel that otherwise would be wasted; provide energy to produce oil naturally, prevent water encroachment, increase the life and usefulness of natural gasoline plant operations; increase the ultimate recovery of oil and reduce gas-oil ratios.

By starting in the early life of a pool, gas may be made available from high pressure traps to absorbers at pressures sufficient to eliminate one or two stages of compression and the corresponding machinery cost. From such intake pressures, one or two additional stages will be sufficient to compress the gas for return to the formation against any known pressure. The highest known pressures used for return of gas were 4600 pounds per square inch used by Continental Oil Company at the Tepetate field, Louisiana.

Gas taken off traps under high pressure contains mostly methane and ethane. Very small quantities of condensible vapors are removed and the gas is too lean in gasoline content to process economically in a gasoline plant. Such gas may be taken directly to high pressure compressor intakes for direct return to the formation. This method of operation reduces the size of the gasoline plant required, as it will only have low pressure gas to process. The small amount of light recoverable ends carried out with the high pressure gas will ultimately be recovered, and the return of these ends provides a washing action in the sand tending to increase ultimate recovery.

Two stage separation may be used on high pressure wells to provide gas at elevated pressures for compressor intake. Oil from the high pressure separator is carried to a low pressure separator, and from there through a stabilizer (if required) to control its final vapor pressure. The flow sheet on the opposite page shows the plant layout. Gas from the low pressure separator is carried through a conventional absorber plant. This gas will be rich in gasoline content, as it is largely solution gas liberated by the pressure drop between the two separators. Leaving the absorber the gas is compressed up to the suction pressure of the high pressure compressors for return to the producing formation. The waste vapors from the crude stabilizer are compressed and circulated through the absorber, where condensable fractions are saved in the gasoline produced.

The proper pressure for operation of the high pressure separator is determined only by field tests. All wells will show an optimum range of separation pressure, where the liquid content of the fluid will be greatest and with minimum gas-oil ratio. The pressure for best separation varies with the formation, gas-oil ratio, and hydrocarbon composition.

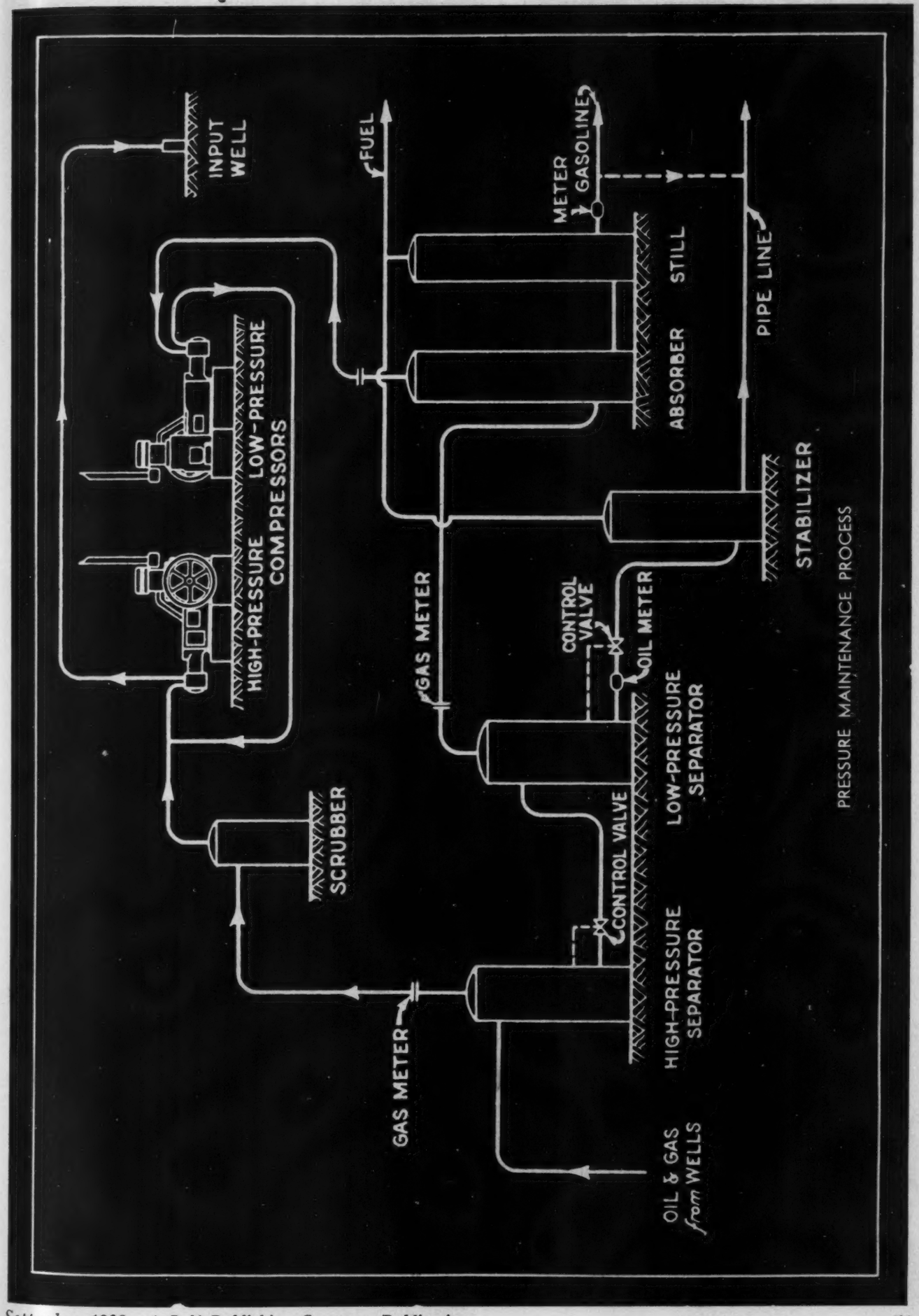
Although the gas take off high-pressure separators is relatively dry, its recoverable gasoline content should be considered in working out the balance between loss of revenue from such gasoline, against the cost of lowering the working pressure of the separators to normal plant pressure and then compressing the residue up through the required stages to well input pressure. In most cases the economic operating conditions will be at the high pressures. These conditions make it feasible to return gas to the formation from wells with extremely high gas/oil ratios, and maintain continued production without waste at reasonable lifting costs over long periods. Operations of this type will save gas in the formation for future consumption. The machinery cost for single-stage compression is relatively low; the operation expense will also be low.

In some formations of the so-called distillate-well type, all of the hydrocarbon compounds exist in the gas-phase. Hence the distillate production, generally a water white product, does not exist as such in the formation. Its appearance is due to retrograde condensation.

The products of such fields are best recovered under a complete pressure maintenance program. Many such plants will be installed for proper handling of such projects. If the stripped gas is not returned to the formation, the pressure will rapidly decline to the point where valuable hydrocarbon fractions in the gas phase will condense to liquids due to the change in physical conditions. This condensate will wet the sand grains (otherwise dry) and a large portion of it will be made irrecoverable for all time.

Continued production of such fields with such high gas-oil ratios will soon deplete the largest reserves. Gas could be returned to the formation at high pressures for a few cents per barrel for the condensate produced, and the process can be continued without waste or rapid depletion of reserves, greatly increasing ultimate recovery, and producing gasoline cheaply during the entire period. It has been shown that when pressure in such fields is reduced to less than 1200 pounds per square inch in the formation, as much as 25 percent of the otherwise recoverable liquids will be lost by wetting the sand. The liquid products being obtained by this process from gas-phase reservoirs is due to retrograde condensation, and a high percentage of the volume can be produced without loss in the reservoir if pressure is maintained.

The foregoing brief description of pressure maintenance processes for gasoline production is based on a paper "Pressure Maintenance" by E. O. Bennett, Continental Oil Company, presented before the American Petroleum Institute, Division of Production, May 24, 1938, and for full details of the process and its widening application the reader is referred to the original paper.


INPUT WELL
FUEL
METER
GASOLINE
HIGH-PRESSURE LOW-PRESSURE COMPRESSORS
ABSORBER
STILL
PIPE LINE
GAS METER
CONTROL VALVE
OIL METER
SCRUBBER
CONTROL VALVE
LOW-PRESSURE SEPARATOR
STABILIZER
GAS METER
HIGH-PRESSURE SEPARATOR
OIL & GAS from WELLS
PRESSURE MAINTENANCE PROCESS

[*Continued from page 414*]

62.3° A.P.I. The kerosine distillate of 42.6° A.P.I. totals 10.7 percent. The gas oil content is 13.4 percent of 35.2° A.P.I. gravity. Total non-viscous lubricating distillate was 9 percent with gravity range of 32.5-28.6° A.P.I. and the fraction of medium lubricating distillate totaled 6 percent with gravity range of 28.6 to 26.1° A.P.I. No viscous lubricating distillate was reported. The residuum totaled 15.8 percent of 18.1° A.P.I. gravity. Carbon residue of the residuum was 6.7 percent, and carbon residue of the crude was 1.1 percent.

A sample of crude oil for comparison was taken from the Blackwell-Helmerich & Payne Wilson 1, a discovery well in the Panther area, which is approximately 13 miles southeast of the Kadane Mangold well. A distillation summary on this crude includes 41.0 percent gasoline and naphtha, 10.3 percent kerosine distillate, 13.7 percent gasoline oil, and heavier distillates. This sample indicates little difference in oil from the two wells.

Deaths and Accidents

ACCIDENTAL deaths in the petroleum industry last year stood at only half of the nation's general accident death rate, according to a report of the American Petroleum Institute's Department of Accident Prevention. Reports covering 324,956 workers in 131 petroleum companies show a fatality rate of 36.9 deaths per 100,000 persons, as compared with the national accidental death rate of 82 fatalities per 100,000 persons in 1937, reported by the National Safety Council.

According to the study of 101 fatalities embraced in the report, 47 percent of the deaths were caused by falls, falling objects and other miscellaneous causes; 25 percent involved trucks or automobiles, and only 17 percent by fires or explosions. Electrical deaths increased during last year and stood at 9 percent, as compared with 3 percent for the year previous. Asphyxiation caused 3 percent of the fatalities.

In the transportation field, operators of motor vehicles owned by oil companies had 65 percent fewer accidents last year per mile traveled than did the average operators of commercial vehicles. The motor vehicle accident record of the industry during last year reveals 10.5 percent fewer accidents than in the preceding year and represents the best achievement of the past five years. This decline in motor accidents was accomplished despite the nation-wide increase in automotive accidents reports during the same year by the National Safety Council.

Petroleum salesmen making their rounds in automobiles last year hung up an enviable record of only 1 accident for each 97,115 miles traveled. The salesmen of the oil companies report all accidents, including those which involve only minor damage, such as dented mud-guards, etc.

Off duty the petroleum workers are not so safe, apparently. The leisure hours of petroleum workers are more hazardous than the hours spent on duty in the processing and handling of inflammable materials. The fatal accidents among the 152,332 workers employed by 67 oil companies during last year were a third less when on the job than when off-duty. Fatalities during the year were only 46 during working hours for this group, as compared to 69 during leisure hours. Traffic accidents accounted for more than half of the off-duty fatalities.

As Others See Us

UNDER the caption, "Just Foolishness," the London, England, "Sphere" recently made this comment:

"The United States contains 6 percent of the world's area and 7 percent of its population. It normally consumes 48 percent of the world's coffee, 53 percent of its tin, 56 percent of its rubber, 21 percent of its sugar, 72 percent of its silk, 36 percent of its coal, 42 percent of its pig iron, 47 percent of its copper and 60 percent of its crude petroleum.

"The United States operates 60 percent of the world's telephone and telegraph facilities, owns 80 percent of the motor cars in use, operates 33 percent of the railroads. It produces 70 percent of the oil, 60 percent of the wheat and cotton, 50 percent of the copper and pig iron, and 40 percent of the lead and coal output of the globe.

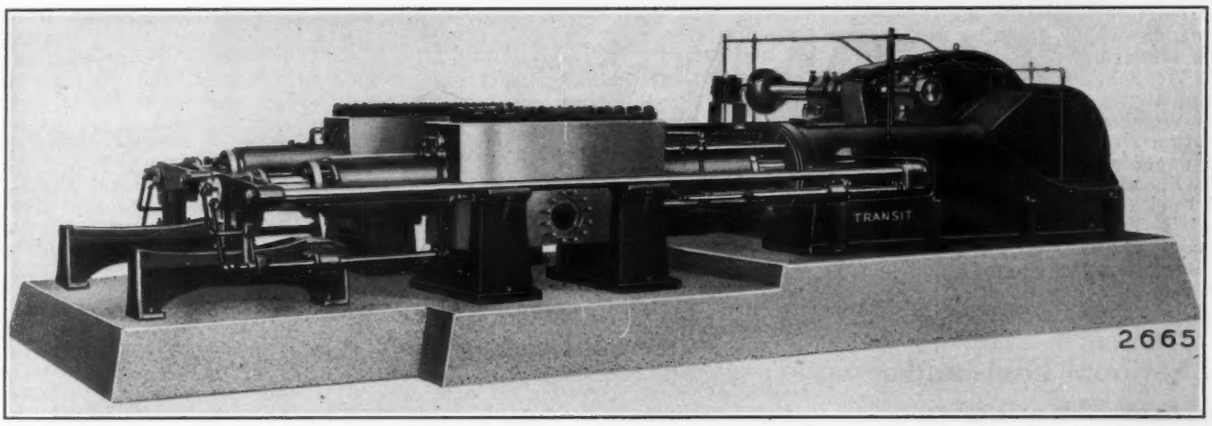
"The United States possesses almost $11,000,000,000 in gold, or nearly half of the world's monetary metal. It has two-thirds of civilization's banking resources. The purchasing power of the population is greater than that of the 500,000,000 people in Europe, and much larger than that of the more than a billion Asiatics.

"Responsible leadership which cannot translate such a bulging economy into assured prosperity is destitute of capacity. But pompous statesmen, looking over the estate, solemnly declare that the methods by which it was created are all wrong, ought to be abandoned, must be discarded; that the time has come to substitute political management for individual initiative and supervision."

(Note—We picked it up from Hercules Supply Company's interesting Herk U. Lee's Log Book, issue of July, 1938, to whom, thanks.)

TRANSIT HOT OIL PUMPS ENGINEERED TO THE JOB

The selection of pumps for hot oil service is an engineering proposition. As specialists in designing and building such pumps, we offer the services of our engineering department to assist you in the proper selection.



Any type of prime mover can be used with this latest type of TRANSIT Hot Oil power pump.

Size shown is a 5¼ x 18″ Horizontal Duplex plunger type for 800° Fahr. oil against 800 lb. pressure. Capacity—240 gallons per minute of hot oil. Of course, this is only one of many sizes and types we manufacture.

Forged steel liquid cylinders with integral stuffing boxes water jacketed.

Liquid cylinders supported along center line of bore by water cooled saddles. This patented arrangement permits the cylinders to expand in all directions with no change in the alignment.

Can be furnished with all moving parts completely protected by dust proof enclosures, if so ordered.

NATIONAL TRANSIT PUMP AND MACHINE CO.

OIL CITY, PENNSYLVANIA

NEW YORK - PHILADELPHIA - CHICAGO - CLEVELAND - PITTSBURGH - LOS ANGELES - HOUSTON - TULSA

Frick-Reid Supply Corporation
108 N. Trenton Ave.,
Tulsa, Oklahoma

The Lang Company
267 West First South St.,
Salt Lake City, Utah

Standard Supply and Hardware Company
822-838 Tchoupitoulas St., New Orleans, Louisiana

MEMBER HYDRAULIC INSTITUTE U.S.A.

Pratt-Gilbert Company
Phoenix, Arizona

Transit Pump & Engine Co.,
2261 East 15th St.,
Los Angeles, California

Reeves & Skinner Machinery Co.
2211 Olive Street,
St. Louis, Missouri

Eugene V. Winter Co.,
19 Main Street,
San Francisco, California

W. P. R. A. Regional Technical Meetings

VARIOUS phases of refining economics will be treated in the two regional technical meetings of the Manufacturing Committee of the Western Petroleum Refiners Association to be held in Wichita, Kansas, and Shreveport, Louisiana, this fall, according to the announcement by L. D. Mann, chairman of the manufacturing committee.

The Wichita meeting has been scheduled for September 29 at the Allis Hotel and the Shreveport meeting will be October 28 at the Washington-Youree Hotel. While the programs are not complete the following subjects will be among those discussed:

"Economic Comparison of Cracking to Fuel Oil versus Coke," by Dr. Gustav Egloff and George B. Murphy, Universal Oil Products Company.

"Safety in its Economic Relation to the Refiner," by Henry W. Boggess, Safety Engineer, Sinclair Prairie Oil Company.

"Furnace Walls and Arches," by M. H. Detrich Company.

"Demands on the Refining Industry by the Modern Automobile Engine," by W. W. Scheumann, Cities Service Oil Company.

The Western Petroleum Refiners Association also announces that it will have a paper on Mid-Continent Lubricating Oils at the SAE National Regional Fuel and Lubricants meeting to be held in Tulsa, October 6 and 7. J. V. Brazier, assistant to the vice president, Barnsdall Refining Corporation, will present the paper.

SAE National Fuels and Lubricants Meeting

GASOLINE and oil will get careful attention from automotive and petroleum engineers at the National Fuels and Lubricants Meeting of the Society of Automotive Engineers at the Hotel Mayo, Tulsa, October 6 and 7.

Two days of technical meetings, each winding up with a dinner, will serve as a forum for leading engineers of these two industries to discuss their mutual problems. On the evening of the second day teams from the Kansas State College and the University of Oklahoma will debate, "Resolved: That Rear Engine Mounting Is More Desirable than Forward Engine Mounting for Passenger Cars."

John A. C. Warner, general manager of the society, reports that arrangements for the meeting have been going forward under the sponsorship of the society's fuels and lubricants activity headed by B. E. Sibley, Continental Oil Company, a vice president of the society. William F. Lowe, Natural Gasoline Association of America, is general chairman and J. V. Brazier, Barnsdall Refining Corporation is local chairman. Serving on the meeting committee are: T. J. Schuetz, Braden Winch Company; A. V. Bourque, Western Petroleum Refiners Association; C. A. Tangner, Downtown Chevrolet Company, (Tulsa), and G. C. Richardson, Indian Territory Illuminating Oil Company.

The Look Box

American Society of Mechanical Engineers

A SYMPOSIUM on Rubber will be sponsored by the Committee on Rubber and Plastics at the Fall Meeting of the American Society of Mechanical Engineers, to be held at the Providence-Biltmore Hotel, Providence, R. I., October 5-7.

The papers to be presented at this meeting will particularly emphasize mechanical problems in the production and use of rubber. These are:

Session 1—October 5, 9:30 a. m.

1. The Engineering History of Rubber, by Dr. W. C. Geer, Ithaca, N. Y.
2. Synthetic Substances with Rubber-like Properties, by E. R. Bridgwater, E. I. du Pont de Nemours & Company, Wilmington, Delaware.

Session 2—October 5, 2:00 p. m.

1. Problems in the Production of Rubber, by E. G. Kimmich, Goodyear Tire and Rubber Company, Akron, Ohio.
2. The Mechanical Characteristics of Rubber, by F. L. Haushalter, B. F. Goodrich Company, Akron, Ohio.

The committee on rubber and plastics will meet in the evening of October 5 to discuss projects for 1939 and 1940. Technical representatives of companies engaged in either the production or use of rubber and plastics are invited to attend.

SEPT. 14–16	National Petroleum Association, Hotel Traymore, Atlantic City, New Jersey.
OCT. 3–4	National Lubricating Grease Institute, Sixth Annual Meeting, Chicago.
6–7	Society of Automotive Engineers, National Regional Fuels & Lubricants Meeting, Tulsa, Oklahoma.
10–14	National Safety Congress, Petroleum Section, Stevens Hotel, Chicago.
10–14	American Gas Association, Atlantic City, New Jersey.
19–21	Independent Petroleum Association, of America, Tulsa, Oklahoma.
26	National Petroleum Association, Department of Fire & Accident Prevention, Semi-Annual Meeting, Olean, New York.
NOV. 11–18	National Automobile Show, Grand Central Palace, New York City.
14–18	American Petroleum Institute, Stevens Hotel, Chicago.
DEC. 5–9	American Society of Mechanical Engineers, New York. N. Y.

Montana Bituminous Conference October 10-13

THE Montana National Bituminous Conference will move into the Mid-Continent area this year and, under the joint sponsorship of the Western Petroleum Refiners Association, the Montana and Mississippi Highway departments, will hold its four-day forum on asphaltic highway construction and maintenance at the Edgewater Gulf Hotel, Biloxi, Mississippi, October 10 to 13.

This year's meeting is the fourth in a series of highly successful conferences in which highway engineers and asphalt technologists and chemists from the petroleum industry have met to discuss the best methods and technique to insure successful use of the petroleum industry's production of asphalt for highway paving. The three previous meetings have been held in Glacier National Park, Montana.

Representatives of 35 states and two provinces of Canada have accepted places and will prepare papers for discussion at the Biloxi meeting. All the Mid-Continent states, Rocky Mountain states, Ohio River valley states and Gulf Coast states are included as well as many Pacific and Atlantic Coast states. Ten papers are being prepared on asphaltic research, construction and maintenance by asphalt industry representatives.

A total of 53 individual papers and reports are being prepared for the 1938 Montana Conference. Following the methods of previous conferences only four papers will be presented during the conference. Those four, however, will be exhaustive analyses of bituminous practice as described in the individual papers. The four papers presented at the conference will be those of the section chairmen. The individual reports and papers will be published in detail in the conference proceedings.

The four chairmen and the subjects which they will discuss:

"Progress in Research as Related to Bituminous Construction and Maintenance of Bituminous Surfaces," Norman W. McLeod, Regina, Saskatchewan, Canada.

"Fundamentals of Bituminous Construction," T. E. Stanton, Materials and Research Engineer, California Highway Department.

"Construction of Bituminous Surfaces," V. B. Steinbaugh, Chief Engineer, Michigan Highway Department.

"Maintenance of Bituminous Surfaces," A. B. Nuss, State Highway Engineer, Kansas Highway Department.

The Conference will be directed by an executive committee composed of D. A. McKinnon, State Highway Engineer, Montana Highway Department, chairman; C. M. Boggs, President, Western Petroleum Refiners Association, vice chairman, and D. L. Cheney, Bituminous Engineer, Montana Highway Department, vice chairman.

The Montana Conference takes on added significance this year because of the steady increase in the production of asphaltic highway materials, particularly by Mid-Continent refiners. In the last six years, a recent survey discloses, Mid-Continent refiners have increased their production of the higher

EMPTY SPACE SHOWS WHITE LIQUID SHOWS BLACK
PENBERTHY
Reflex GAGES
Preferred wherever liquid levels must be easily and positively visible . . . and when liquids are under pressure or at high temperature. Exceptionally rugged construction and made in any length desired for various kinds of liquids. Let us quote upon your requirements.
PENBERTHY PRODUCTS
PENBERTHY INJECTOR COMPANY
Manufacturers of QUALITY PRODUCTS Since 1886
DETROIT, MICH. • Canadian Plant, Windsor Ont.
Multiple Type Gage equipped with Drop Forged Steel Gage Valves.
FRAME BOLT
LIQUID CHAMBER
GASKET
GLASS
ASBESTOS CUSHION
FRAME

grades of asphalt more than 400 percent, an effort which has caused the investment of large sums in more advanced equipment. A meeting such as the Montana conference, which brings about better methods of using the asphaltic production also results in increased consumption.

Universal Reduces Royalty Rates

UNIVERSAL Oil Products Company recently announced a reduction of 5 cents per barrel throughput for Dubbs cracking, thus cutting the present rate of 10 cents per barrel squarely in half. Substantial reductions likewise are being made in the rates for reforming and viscosity-breaking operations. The new rates, which take effect October 1, apply only to refiners, some 60 in number, using the Dubbs process in the United States.

This is the second major royalty reduction that has been made by this company and brings the rate down to one third of what it was in the beginning. While the curve of cracking royalty costs has been steadily dropping, yields of gasoline and anti-knock value have been steadily going up. When the first commercial Dubbs cracking unit was put in operation in 1919, the royalty was 15 cents per barrel and the yield of gasoline then guaranteed was only 21 percent. In 1934 when the 15-cent rate was cut one third, gasoline yields had reached 50 percent or more.

Today many refiners are getting yields of 60 percent or considerably better from their cracking operations, stabilized gasoline of suitable vapor pressure, high volatility and high octane rating.

Universal Oil Products Company has also developed and is developing other important refining processes, including catalytic polymerization, iso-octane production, catalytic cracking, catalytic reforming, alkylation and production of aromatics, as well as gasoline inhibitors.

Gasoline Products Royalties Reduced

GASOLINE PRODUCTS COMPANY, licensor for many years of the Cross, Holmes-Manley and DeFlorez cracking processes, and more recently, with its licensing agent, The M. W. Kellogg Company, originator of the modern "Combination" and "Unicoil" processes, announces reductions in the royalty rates for its various processes for the United States and Canada.

As in the past, Gasoline Products Company will continue to grant licenses either on basis of charge or of gasoline produced and either on a running or paid-up basis. All of these licenses may be obtained with "defense only" or with full obligation on the licensor to "defend and hold harmless." Effective October 1, 1938, the rates based on fresh charge to regular cracking units will be 5 cents per barrel for "defense and hold harmless" and 4 cents per barrel for defense only." Rates based on gasoline produced will be proportionately reduced, and paid-up rates will also be subject to reductions. Special rates for reforming will be continued.

The company will continue to provide engineering and general consulting service to its licensees.

Forecast Demand Motor Fuel, Crude Oil, Sept. 1938

THE daily average supply of domestic crude oil estimated by the Bureau of Mines to meet the market demand in September, 1938, is 3,444,300 barrels. This is 6200 barrels higher than the estimate for August 1938, 221,700 barrels (6 percent) less than the daily average production for September 1937, and 7 percent less than the demand for domestic crude for that month. This decrease in the estimated demand is due principally to larger estimates of gasoline stock withdrawals.

Daily average crude-oil production and runs to stills during the four weeks July 2 to July 30, averaged 3,334,000 barrels and 3,200,000 barrels, respectively. During this period stocks of refinable and heavy crude declined 3,029,000 barrels. However, foreign stocks increased 92,000 barrels, making a decline in domestic grades of 3,121,000 barrels, or 111,000 barrels daily. The addition of this amount to production gives 3,445,000 barrels as the apparent daily average demand for domestic crude oil during this period, compared with 3,398,100 barrels estimated by the bureau for July.

The estimate for domestic motor-fuel demand for September, 1938, is 47,000,000 barrels, or 0.5 percent lower than the actual demand for September, 1937.

Motor-fuel exports have been estimated at 4,400,000 barrels, 100,000 barrels less than was estimated for August and 56,000 barrels less than the actual exports for September, 1937.

Stocks of finished and unfinished gasoline amounted to 80,531,000 barrels on June 30. According to statistics of the American Petroleum Institute, these stocks declined approximately 4,500,000 barrels during July, bringing them to approximately 76,000,000 barrels as of July 31. If the bureau's estimate of 6,300,000 barrels as the August withdrawal materializes, there will be a little less than 70,000,000 barrels of gasoline on hand as of August 31, compared with about 67,000,000 barrels on the same date in 1937. For September, 1938, the bureau estimates a further reduction of 3,700,000 barrels, compared with an actual withdrawal of about 1,400,000 barrels in September, 1937. Stocks of gas oil and distillate fuel oil on June 30 were 20 percent higher than last year, while residual fuel oil stocks were 18 percent higher, indicating the possibility of a substantial reduction in crude runs in the last quarter.

Benzol and direct sales and losses of natural gasoline have been estimated as 900,000 barrels, making the estimated refinery production of gasoline 46,800,000 barrels. This is distributed among the various districts as follows (thousands of barrels): East Coast, 6,290; Appalachian, 1,630; Indiana-Illinois, 8,250; Oklahoma, 2,710; Kansas, 2,550; Inland Texas, 3,890; Texas Gulf Coast, 11,750; Louisiana Gulf Coast, 1,440; North Louisiana-Arkansas, 940; Rocky Mountain, 1,170; California, 6,180.

Natural-gasoline consumption at refineries in September is estimated as 8.5 percent of the total gasoline production, or 3,980,000 barrels. The yield of straight-run and cracked gasoline is estimated as 44.4 percent compared with 44.2 percent for August, 1938, and an actual of 43.5 percent for September, 1937. The application of the current yield to the estimated straight-run and cracked gasoline production of 42,820,000 barrels gives refinery crude-oil requirements as 96,430,000 barrels, or 3,214,000 barrels daily.

Foreign crude runs to stills are estimated at 2,400,000 barrels, 100,000 less than the August estimate.

The estimate for crude-oil exports has been decreased 700,000 barrels from the August estimate to 7,000,000 barrels, while the estimate for fuel and losses remains the same, 2,300,000 barrels.

The subtraction of foreign crude runs and the addition of the exports, fuel, and losses, gives a total crude oil demand of 103,330,000 barrels, or 3,444,300 barrels daily.

Petroleum Technology In 1937 Published

THE Institute of Petroleum has published "Petroleum Technology in 1937." This is the third volume in the series of annual reviews of technical progress in the petroleum and allied industries prepared by the Institute of Petroleum (formerly the Institution of Petroleum Technologists). It maintains the authoritative character of its predecessors and is about 50 percent larger than the corresponding volume of last year. Volume three covers the literature published during 1937 and contains about 2500 bibliographical references.

One of the most remarkable features of the work is its international character. Reviews of progress are not limited to developments in English speaking countries, but cover the world. There are, for example, full reports on the operations of synthetic processes in Germany, developments in cracking in the U. S. S. R. and a concise record of geological and exploration work in all countries where such work has been carried out.

The book is well arranged and handy for reference. There is very little duplication in its 27 chapters which cover the whole field of the petroleum industry from petroleum geology to the utilization of its products in automobile and aero engines. Approximately 100 pages are devoted to the subject of "alternate fuels" (motor benzols, carbonization processes, hydrogenation and the Fischer-Tropsch synthesis). This 490-page volume can be secured from the Institute of Petroleum, Aldine House, Bedford Street, Strand, London, W. C. 2, and the price is 11 shillings.

Instrumentation Contest Announced

AN instrumentation contest with a first prize of $200.00 in cash is announced by the Industrial Instrument Section of Scientific Apparatus Makers of America.

Twelve prizes in all, totaling $500.00, will be awarded by the Apparatus Makers. The contest is open to any engineer or operating man, not em-

ADVANTAGE..

Sun-Alco Propane Dewaxing

Sun-Alco Propane Dewaxing presents three distinct advantages:—

1. **Continuous Chilling Versus Batch Chilling**
2. **Indirect Chilling of Low Propane Dilution Blends Versus Auto-Evaporative Chilling of High Propane Dilution Blends**
3. **Simultaneous Dewaxing, Deresining and Deasphalting, Versus Separate Steps**

Blends vary from 1 part propane and 9 parts charge oil for wax distillate stocks to 5 parts propane and 1 of charge oil for residual stocks. The original blend is continuously chilled by indirect exchange refrigeration to effect approximately 90% of the total blend chilling, is brought to final dilution by the addition of cold propane, and is auto-refrigerated to the final temperature.

Dewaxing, Deresining and Deasphalting of the final blend is accomplished simultaneously in a single step.

Indirect chilling, cold propane dilution, final chilling, and simultaneous dewaxing, deresining and deasphalting of the blend under controlled conditions result in Fast Chilling, Efficient Recovery of Refrigeration, High Filtering Rates, High Oil Recovery, Better Deresining and Continuously Uniform Results.

Alco engineers are ready to study the application of this process to your particular problem.

ALCO PRODUCTS

DIVISION OF

AMERICAN LOCOMOTIVE COMPANY
THIRTY CHURCH STREET NEW YORK, N. Y.

AMERICAN LOCOMOTIVE SALES CORP.
ARTILLERY HOUSE, ARTILLERY ROW, LONDON, S. W. 1, ENGLAND

ployed by an instrument manufacturer. Each contestant is to write about an unusual application of a standard instrument or control device, telling briefly what conditions or need impelled the application. By instrument or control device is meant any device used for measurement or control in a plant or laboratory, or any accessory used with a device for measurement and control.

The contest will be judged by the following Jury of Award—Chairman Lyman J. Briggs, (director, National Bureau of Standards). Members: M. F. Behr (editor "Instruments"); W. E. Forsythe, (physicist, Nela Park Research Department, General Electric Company); John J. Grebe, (director of physical research laboratory, Dow Chemical Company); R. J. S. Pigott, (head of engineering department, Gulf Research & Development Company), and ex-officio Phil T. Sprague, (chairman, industrial instrument section S. A.M.A. and president of the Hays Corporation.)

The contest closes November 15, 1938, and the judging will be held during the week of December 5.

Copies of the contest rules and official entry form can be obtained from Scientific Apparatus Makers of America, 20 North Wacker Drive, Chicago.

CORRECTION

In the August, 1938, issue of THE REFINER, *which was the Foreign Refining Development number, there was presented a sixteen page pictorial section where 26 refining installations throughout the world were illustrated. Four of these photographs are misleading because of mis-labeling, for which the editors apologize, to* REFINER'S *readers and to the four concerns kind enough to loan us the photographs.*

Those desiring accuracy or for those interested in knowing the truth about the location of the four mis-handled illustrations we refer to the first three pages of the pictorial section which would be pages 361, 362 and 363. Page 361 devoted to Canada is all right and the photographs are as they were supposed to be. However, on the following spread something happened. The photograph at the top under the title "Ecuador," is an untruth. The plant is in Argentina and is a combination two-stage atmospheric distillation unit erected by E. B. Badger & Sons Company for Ultramar Petroleum Company at Buenos Aires.

The photograph at the bottom of this page, titled "Argentina" is also far from true. The plant is in Ecuador and is a 1500-barrel distillation unit erected for Anglo Ecuadorian Oilfields, Ltd., at La Libertad by Stratford Engineering Corporation.

On the following page, titled "Argentina," the legends accompanying the photographs have been reversed. The upper picture is the combination topping, cracking and stabilizing plant with a multi-coil thermal polymerization plant erected for Argentine Government Oil Fields at La Plata by Alco Products Division, American Locomotive Company, while the lower picture is that of a 3200-barrel Dubbs reforming unit at Buenos Aires, Argentina, licensed by Universal Oil Products Company. The remaining 22 photographs in the pictorial section are correctly presented. It must have been the weather!

Hydrogenation of Pyrolitic Tars

TECHNICAL Paper 587, "Studies Pertaining to the Catalytic Hydrogenation of Pyrolytic Tars," by H. M. Smith, H. T. Rall and Peter Grandone, has been published by the Bureau of Mines and copies can be secured from the Superintendent of Documents, Washington, price 10 cents. The bulletin covers development of an apparatus for testing the activity of metals in catalyzing gas-phase hydrogenation reactions under static conditions. The experiment data on the hydrogenation of naphthalene in the presence of a number of different metallic catalysts are given. These data show that: Hydrogenation to both tetra- and decaderivative in the gas phase is possible; the rate of the hydrogenation reaction in these experiments depend upon the concentration of the hydrogen, the temperature, and the activity of the catalyst. Curves showing the relationships between the reaction rates and other variables are given. The preparation of the several catalysts is described in detail and their activity, expressed as a function of the reaction time, has been calculated. Of the catalysts tested, platinum, palladium, nickel and cobalt appear to be the most active metals. The hydrogenation of naphthalene in the tar formed by cracking natural gas is described. A nickel catalyst is used, and both small and large-scale laboratory apparatus are described in which the reaction has been conducted successfully. Methods of separating the naphthalene from the heavier tars are given, and finally, data on successful runs are given where gas cracking to light oil and tar is combined with tar separation and hydrogenation, using the hydrogen formed in the cracking process. A distillation analysis of the products is shown.

AMERICAN CHEMICAL SOCIETY

Abstracts of Papers

Presented at Milwaukee, Wisconsin, September 5 to 9, 1938

Motor Fuel Economy of Europe. GUSTAV EGLOFF, *Universal Oil Products Company Research Laboratories, Chicago.*

Self-sufficiency strikes the keynote for the desires of most European nations. The production of substitute motor fuels derived from their own resources such as coal, wood, oil, shale, and agricultural products is one of the goals. The economics involved is not the primary factor.

Coal is converted into liquid motor fuel by carbonization, hydrogenation, and the water gas reaction. Alcohols from farm products and methanol from hydrogenation of carbon monoxide and wood distillation are also used.

Methane, ethane, propane, and butanes, or city gas, are used in a compressed form in steel cylinders (3000 to 4000 pounds pressure) in gas-driven motor vehicles. These gases are derived from coal carbonization, hydrogenation, and hydrogenation of carbon monoxide and natural gas. There are about 2000 of this type of motor vehicle in use. Other types of gas-driven vehicles manufacture their own combustible gas en route from wood and charcoal. There are about 9000 such wood-burning motor vehicles in Europe consuming about 450,000,000 pounds of wood yearly. These motor vehicles are heavily subsidized by governments through direct payments, elimination of taxes on the wood and vehicle, and taxes on imported gasoline.

Total consumption of power alcohol in Europe in 1937 amounted to 510,000 tons compared with 646,000 tons during 1936. The 510,000 tons of ethyl alcohol (some methanol) represented 4.3 percent of the total 11,882,600 metric tons of motor fuel consumed during 1937 in Europe. It is estimated that the 510,000 tons of alcohol used in Europe cost the consumer and state in additional expenditures on the order of about $100,000,000 in subsidies, tax losses, and higher operating costs of vehicles.

Ethyl Fluid Blending Chart for Motor Method Octane Numbers. L. E. HEBL, T. B. RENDEL, AND F. L. GARTON, *Shell Petroleum Corporation, Engine Research Laboratory, Wood River, Illinois.*

A chart has been constructed such that a linear interpolation is obtained between A.S.T.M.-C.F.R. motor method octane numbers and tetraethyllead concentrations in any base gasoline. This chart allows the "lead susceptibility" of a gasoline to be expressed as a single figure.

Some Factors Affecting the Knock Rating and Lead Susceptibility of Gasolines. FRANCIS G. GRAVES, *Standard Oil Company of California.*

Previous literature on the subject, dealing particularly with the loss of knock rating during acid treatment of cracked gasolines and the influence of composition and sulfur content of gasolines on their lead susceptibility, is reviewed and summarized. Some earlier investigations have furnished a general indication that the loss of knock rating of cracked gasolines during acid treatment was dependent on their nature and source. This paper presents a definite relation between octane number loss for cracked gasolines and their initial knock rating, the latter being dependent in turn on cracking stock origin. Also, composition and sulfur content of gasolines have been recognized as having a direct bearing on their lead susceptibility. Making use of a numerical expression for lead susceptibility developed by other investigators, relations between this characteristic and sulfur content are developed for straight-run and cracked gasolines and aromatic stocks. This relation should prove useful in estimating the lead susceptibility of various gasoline stocks. Paraffin and naphthene hydrocarbons have the highest susceptibility. Al-

NO ONE TUBE A "CURE-ALL"

℞

. . . but every one tried and tested for a specific condition of heat and corrosion

ONE of these still-tube analyses may save you thousands of dollars a year, by arresting corrosion, erosion and scaling, and lengthening the time between plant outages for tube replacement.

And the best way to find out whether your tube-replacement problem will yield to one of these analyses is to turn over the facts to one of our specialists, for thorough technical investigation and recommendations.

With all these 24 analyses from which to choose, the man from NATIONAL Tube is ready to give you "Complete Tube Service"—including everything from an analysis of your requirements, to the final selection of the right size, wall thickness, and steel for tubes that will give you most economical service.

When one of our specialists makes a recommendation, you may be sure it is completely unbiased, for he has no interest in promoting any one analysis over another — merely a wholesome interest in giving you the most performance for your money.

This is the way we earn our right to transact business with you. Why not ask one of our specialists to call and demonstrate the meaning of "Complete Tube Service"?

LOW CARBON	2½% CR. ½ MOLY
COPPER STEEL	3% CR. 1% MOLY.
U·S·S COR-TEN	5% CR. ½ MOLY.
½% MOLY.	5% CR. ½ MO. STABILIZED
1% MOLY.	1% CR. ½ MOLY. 1¼ SIL.
1½% SIL ½ MOLY	2% CR. ½ MOLY. 1¼ SIL.
NICKEL STEEL	3% CR. ½ MOLY. 1¼ SIL.
S. A. E. 2315	5% CR. ½ MOLY. 1½ SIL.
S. A. E. 6120	2¼% CR. 1% MOLY
1¼% CR. ½ MOLY.	9% CR. 1½ MOLY
BAIN ALLOY	U·S·S 18-8
2% CR. ½ MOLY	U·S·S 18-8 STABILIZED

Ask about National's COMPLETE TUBE SERVICE, 24 analyses to choose from.

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

though pure aromatic compounds have a higher lead susceptibility than olefins, they are more sensitive to the effect of sulfur compounds.

The Tetraethyl Lead Susceptibility of Gasolines Treated with Doctor Solution Versus Caustic Washing. L. M. HENDERSON, W. B. ROSS, AND C. M. RIDGWAY, *The Pure Oil Company.*

Mercaptains present in gasoline stocks may be removed to a very large extent by efficient scrubbing with caustic soda solutions. Data are presented to show that gasolines thus treated require less tetraethyl lead for the production of a given octane number or antiknock value than the same gasoline stock treated in the conventional way with sodium plumbite (Doctor Solution) and elemental sulfur. The difference in tetraethyl lead requirement is greater when an excess quantity of sulfur is used in the conventional plumbite treatment. Efficient scrubbing of mercaptan-containing gasoline with NaOH solutions followed by the sodium plumbite treatment possess better tetraethyl lead susceptibility than the same gasoline stock treated only with plumbite solution and sulfur. The spent caustic solutions may be regenerated by boiling and used repeatedly.

Studies in Doctor Sweetening. II. Regeneration of Doctor Solutions. CHARLES WIRTH, III, C. D. LOWRY, JR., AND J. R. STRONG.

The importance of satisfactory regeneration of doctor solution for proper economy is emphasized. The many factors contributing to difficulties in the conversion of lead sulfide to litharge by the usual refinery methods are each discussed. A description of several methods of regeneration in use is given.

Some data are presented showing the advantages of a turbulence column particularly for use by the small refiner. A description of a doctor plant incorporating a satisfactory recovery and regeneration system is given.

The Production of High-Octane Isoparaffinic Fuels by the Addition of Olefins to Isoparaffins. S. F. BIRCH, A. E. DUNSTAN, F. A. FIDLER, F. B. PIM, AND T. TAIT, *Anglo-Iranian Oil Company, Ltd., Sunbury-on-Thames, Middlesex, England.*

In the presence of concentrated sulfuric acid the lower olefins, with the exception of ethylene, react with isobutane to give a product from which a fully saturated fraction b.p. 27° to 185° C. may be isolated by distillation. This material apparently consists entirely of isoparaffins ranging from isopentane to isodecanes and higher. Its high octane rating, roughly 90+, coupled with its low sulfur content, renders it an excellent component for 100-octane aviation gasoline. The reaction is not limited to isobutane and has been extended to isopentane and 2-methylpentane, but the lower octane ratings of the gasoline fractions obtained from these isoparaffins render them less suitable as components for 100-octane fuels. The effect of varying the reaction conditions upon the yield and nature of the product is outlined. As satisfactory starting materials for commercial operation the unsaturated C_4 cut obtained from normal cracking operations may be employed together with an isobutane concentrate taken from natural gasoline stabilization. The heat evolved in the reaction and acid consumption are briefly discussed.

The Thermal Decomposition of Petroleum Hydrocarbons Into Free Radicals. B. L. EVERING, *Standard Oil Company (Indiana), Whiting, Indiana.*

Various close-out naphthas and petroleum butane were heated to temperature near 1000° C. at low pressures. The presence of free radicals in the decomposing hydrocarbons was demonstrated by contacting the vapors with a fresh lead surface (constantly renewed by condensation from vaporized lead), and analyzing the products for lead alkyls. The effect diminishes very rapidly as the pressure is increased above 6 mm. of mercury. The data obtained do not permit any confident statements as to the mechanism involved.

Chemical Reactions of Cracked Residues. HANS TROPSCH, CHARLES L. THOMAS, J. C. MORRELL, AND GUSTAV EGLOFF.

The oil remaining after the removal of asphaltines from cracked residue will react with nitric, sulfuric, and phosphoric acids, chlorine, sulfuryl chloride, anhydrous aluminum chloride, stannic chloride, titanium tetrachloride, ethyl sulfate, and potassium permanganate.

Sulfuric acid treatment raises the viscosity index of the oil. The viscosity of the treated oil can be raised by chlorinating the oil and treating the chlorinated product with anhydrous aluminum chloride and benzene. The optimum amount of chlorine is about 10 percent of the oil. The oils so formed have pour points of 80° to 90° F. due primarily to wax in the original residue.

The Relation Between Catalytic Activity and Size of Particle. E. W. THIELE, *Standard Oil Company (Indiana), Whiting, Indiana*

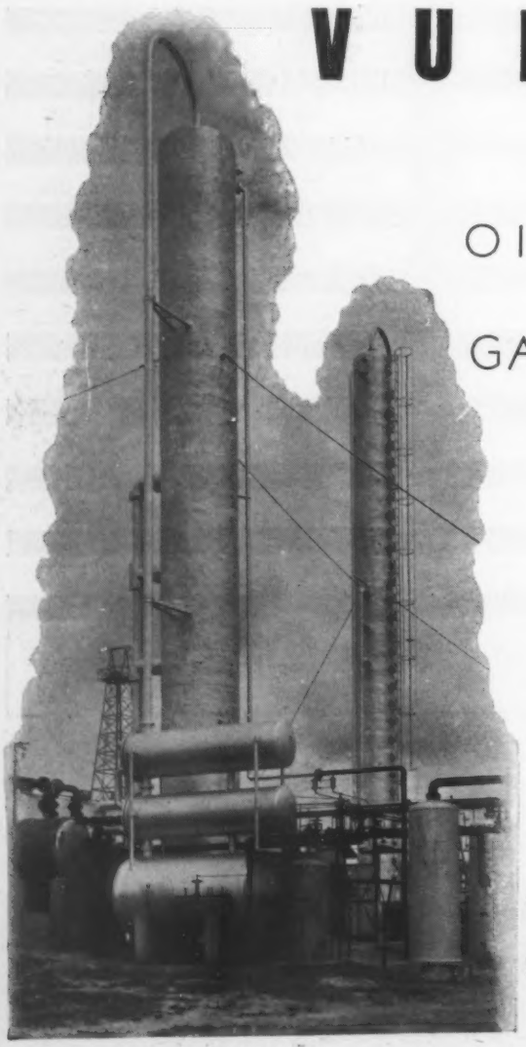
A mathematical treatment, based on reasonable assumptions, indicates that below a certain grain size the activity of a porous catalyst is proportional to the amount present. If the grain size is increased much above this value, the activity will depend on the total external surface of the grains. The dividing region between these two conditions is determined by a dimensionless quantity

$$x_s \sqrt{\frac{c}{rk}}$$

where x_s is the radius of the grains, c is the activity of unit internal surface of the pores, r is the hydraulic radius of the pores, and k is the diffusion coefficient. If consistent units are used, the transition values of the modulus do not differ very greatly from unity.

Bauxite as an Adsorbent for Pennsylvania Oils. OGDEN FITZSIMONS, R. G. CAPELL, AND G. C. JONES.

Activated bauxite and fuller's earth



VULCAN

OIL REFINERY AND GASOLINE PLANT EQUIPMENT

All Materials and Workmanship according to ASME or API Requirements when specified.

See COMPOSITE CATALOG Refinery Equipment Page 275

VULCAN STEEL TANK CORP.

TULSA, OKLAHOMA

BROWN Air-o-Line

Provides the Dollar Saving Solution . . .

. . . In Co-ordinating PROCESS CONTROL

Three years ago when Industry's process control costs were skyrocketing — the Brown *AIR-o-LINE* Controller — affording greater accuracy and outstanding "performance with simplicity" — was offered to Industry.

It proved to be the answer to Industry's cost-cutting problem in process control. Graduated dials for both "Throttling Range" and "Automatic Reset" provided accurate means for operators to "tune in" to specific processes without guesswork.

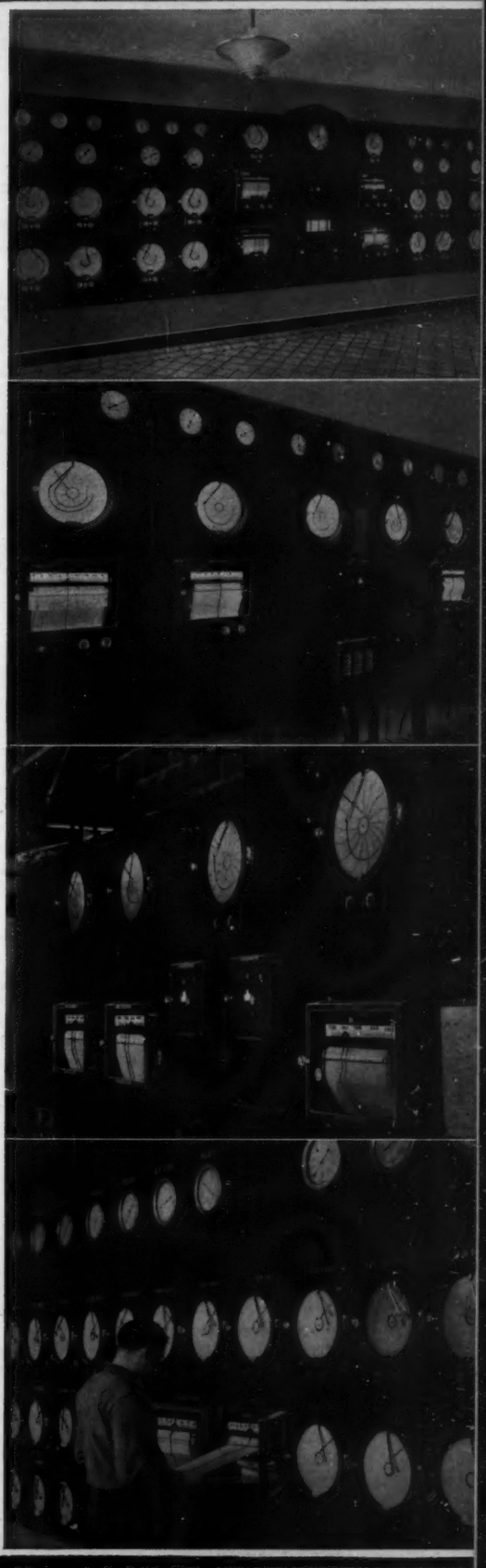
In process control, lack of co-ordination in regulating temperatures, pressures, flows and liquid levels inevitably results in unbalanced operation — with resultant loss in time and money.

Brown *AIR-o-LINE* provides this co-ordination: First, by the simplicity with which *AIR-o-LINE* is "tuned in." Second, by the extreme precision with which it maintains control. The Brown AIR-o-LINE Controller has reduced the most complicated process control problem to the simplicity of dialing a radio.

AIR-o-LINE is easily adapted to any process control problem. Once "tuned in," it becomes fully automatic. It "Recognizes," "Analyzes" and "Corrects" for any departure from the desired control point without "hunting," "cycling" or "drifting."

With *AIR-o-LINE* controlling your processes, you always get the best results — not just "good enough."

Consult us about the process you wish to control. Without obligation, our engineers will be glad to co-operate. Write for Catalog No. 8902. THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Co., 4498 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street. Amsterdam-C, Holland: Wijdesteeg 4. London, England: 70 St. Thomas' Street, S.E.I.



OPERATED CONTROLLERS

OUTSTANDING PERFORMANCE WITH SIMPLICITY

are compared, when used to produce Pennsylvania neutrals and bright stocks by percolation. Bauxite will stand higher burning temperatures than fuller's earth but prolonged overburning is harmful, as the time element, heretofore neglected, is a variable. Bauxite is very sensitive to such variables as percolation rate and mesh, and hence requires unusual care in laboratory evaluations.

No reliable means of evaluating a bauxite as an adsorbent from chemical analysis figures has been found. An apparatus and procedure are described for evaluating adsorbents by percolation wherein temperatures are maintained by circulating organic vapors through double-walled filters.

The Effect of Pressure on Viscosity in Relation to Lubrication. J. W. GIVENS.

An analysis has been made of data on the temperture rises in three oils while lubricating a partial bearing at high loadings. Using the pressure coefficients of viscosity of these oils, an operating variable was calculated that accounted for the observed temperature rises and that should be useful in studying lubrication. Differences in the frictional characteristics of these oils that might be ascribed to oiliness could be accounted for by known properties of the oils. The use of the term "oiliness" to account for such differences admits ignorance of the properties of liquids and the need for this term will disappear proportionately as more exact information becomes available.

Effect of Pressure on Lubricating Greases. BRUCE B. FARRINGTON AND ROBERT L. HUMPHREYS, *Standard Oil Company of California.*

The present report describes experiments on lubricating greases carried out with a grease press designed by W. H. Herschel of the U. S. Bureau of Standards. This apparatus confines the grease under test while pressure is applied and immediately absorbs any oil pressed from the grease. The amount of lubricating oil pressed from several greases after various time intervals was determined and an equation obtained for calculating this quantity. The maximum amount of oil capable of being pressed from the grease under the test conditions was also calculated. This quantity is termed the "Ultimate oil loss." In the oil loss equation two characteristic constants were obtained which measure the initial oil loss rate and the "ultimate" oil loss. These constants change for each grease and each change in the experimental conditions (other than time).

Several factors influencing the initial oil loss rate and the "ultimate" oil loss were investigated, among these being pressure, temperature, viscosity of mineral oil, mineral oil content, and type of soap base.

The "bleeding" of oil from greases in storage was correlated with the initial oil loss rate in the grease press. A routine test procedure was developed, requiring 3 hours' elapsed time and two oil loss measurements to determine the bleeding characteristics of lubricating greases.

Pressing tests on petrolatum, a naturally occurring grease-like material, showed the similarity of this substance to soap base greases.

Miniature Penetrometer for Determining the Consistency of Lubricating Greases. GUS KAUFMAN, W. J. FINN, AND R. J. HARRINGTON, *The Texas Company, Beacon, New York.*

A penetrometer is described which permits the determination of consistency on small samples of grease (4 grams). It has proved a valuable tool in the study of lubricating greases in service, where the A.S.T.M. penetrometer has been inapplicable because of the large samples (453 grams approximately) it requires.

The grease holder is a small brass cylinder, split to permit charging with minimum working. An aluminum plunger (20 grams) replaces the A.S.T.M. cone assembly (150 grams). Since the new penetrometer otherwise employs the usual A.S.T.M. parts, the added expense is trivial.

Results of penetration tests with the new and the A.S.T.M. penetrometers are shown for the usual types of grease.

Determination of Undissolved Sludge in Used Oils. HARRY LEVIN AND CHARLES C. TOWNE, *The Texas Company, Beacon, New York.*

A method is described for determining undissolved sludge in used lubricating oils. It avoids the common errors due to co-precipitation (by the solvent employed) of substances that are actually in solution in the used oil itself. The undissolved sludge is calculated from the pentane-insoluble matter found in the original sample and that found in the cotton-filtered sample.

Determination of Dissolved Sludge in Used Oils. FRANK W. HALL, HARRY LEVIN, AND WALLACE A. MCMILLAN, *The Texas Company, Beacon, New York.*

A method and apparatus are described for determining dissolved sludge in used lubricating oil. The material of the clarified sample which is insoluble in liquid propane at common room temperature is classified as dissolved sludge. The paper points out the limitations of the method, indicates its utility, and explains why extensions of the principle of the method are not used.

Chloro-Organic Compounds in Relation to Cracking Coil Corrosion. R. H. GARDNER, JOHN W. TETER, AND L. I. HANSEN, *Sinclair Refining Company.*

Chloro-Organic Compounds From Salts

Gas oil heater coils evinced corrosion when gas oil from a high-salt Mid-Continent crude was cracked. Traces of chlorine compounds were found in the commercial gas oil heater feed. The immediate problem was to confirm the formation of chloro-hydrocarbons in the crude heat exchange and flashing steps, since such compounds would subsequently decompose at cracking temperatures to give HCl.

Since $MgCl_2$ was believed to be the main source of active chlorine a M-C crude and several fractions were digested with $MgCl_2$ and water under conditions comparable to crude heat exchange and flashing operations. Digested samples, after careful washing and drying, contained chlorine in the order of 0.0007 to 0.002%. Therefore, chlorination of certain oil molecules can occur by reaction of $MgCl_2$.

Chloro-Organic Compounds From CCl_4

The question has been raised concerning the effects on refinery operations should CCl_4 be used in cleaning out oil wells.

Crude oil was heated with CCl_4 and moisture under conditions of crude heat exchange (350° F.). HCl was evolved copiously. Organic chlorine was found in the household heating oil, gas oil, and residuum fractions in the order of about 0.12%. Therefore, chloro-compounds are produced.

In commercial operation whatever CCl_4 did not decompose in crude heat exchange before the primary flash would be found in the straight-run gasoline. Regular gasoline blends with CCl_4 showed no significant changes in oxidation susceptibility and antioxidant efficiencies. However, octane and TEL susceptibilities were seriously lowered.

Organic Sulfides. Specific Gravities and Refractive Indices. GEORGE W. AYERS, JR., AND M. S. AGRUSS, *The Pure Oil Company, Chicago.*

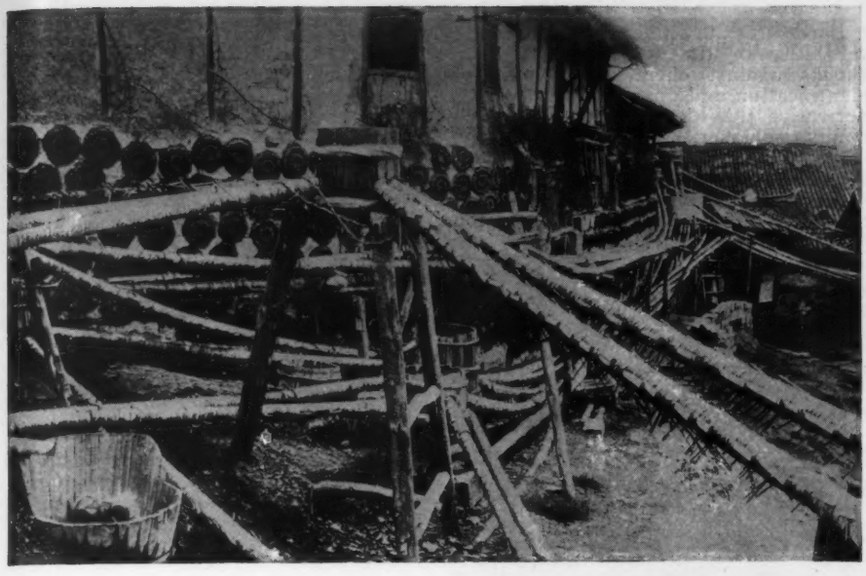
A number of organic sulfides were prepared (except ethyl and *n*-butyl) by adding the corresponding bromides to sodium sulfide in alcohol, and were purified by fractionation. Ethyl and *n*-butyl sulfides were purchased and refractionated.

Sulfide	Boiling Range (Corr.), °C.	Pressure, mm.	0° C. $d\frac{}{4°\,C.}$	20° C. $d\frac{}{4°\,C.}$	25° C. $d\frac{}{4°\,C.}$	20° C. $n\frac{}{D}$	25° C. $n\frac{}{D}$
Ethyl	91.2– 91.5	746	0.8524	0.8331	0.8299	1.4428	1.4395
n-Propyl	141.6–142.1	749	0.8525	0.8358	0.8319	1.4481	1.4456
Isopropyl	118.7–118.9	749	0.8306	0.8136	0.8092	1.4381	1.4354
n-Butyl	186.4–187.0	750	0.8535	0.8386	0.8348	1.4529	1.4504
Isobutyl	168.2–168.8	749	0.8427	0.8262	0.8232	1.4463	1.4439
n-Amyl	227.1–227.5	754	0.8532	0.8390	0.8350	1.4556	1.4532
Isoamyl	214.3–214.8	754	0.8476	0.8323	0.8284	1.4520	1.4499

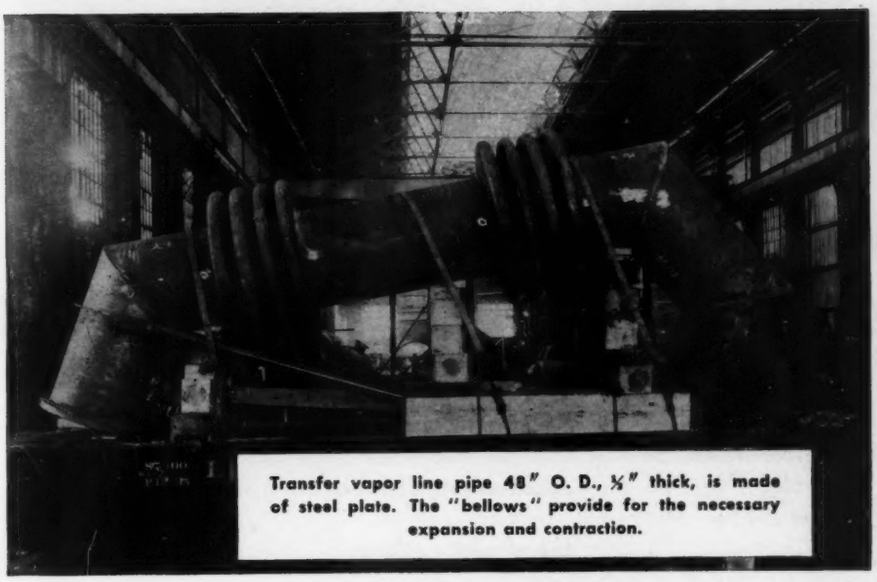
The Ultraviolet Absorption Spectra of Simple Hydrocarbons. EMMA P. CARR, AND HILDEGARD STUCKLEN, *Mount Holyoke College, South Hadley, Massachusetts.*

Examination of the ultraviolet absorption spectra of twenty-six unsaturated hydrocarbons, including olefins, di-olefins, and cyclic hydrocarbons in the region 2300 to 1600 A, using a fluorite vacuum spectrograph, has shown that (1) the light absorbed by a given hydrocarbon molecule is determined by the number of hydrogen atoms directly bound to the carbon atoms of the double bond and is independent of the size or arrangement of the alkyl group; (2) there is a progressive shift of absorption toward longer wave lengths as the number of these hydrogen atoms is decreased; (3) the spectra of all cyclic hydrocarbons examined show vibrational fine structure.

The results in general can be used



PIPING OF GRASS



Transfer vapor line pipe 48" O. D., ½" thick, is made of steel plate. The "bellows" provide for the necessary expansion and contraction.

PIPING of STEEL

Piping made of bamboo (a species of grass) has been used in Chinese oil refineries for over 1,000 years. In many of the older plants it is still used today.

Modern methods of refining necessitate the use of piping fabricated from special steels, able to withstand high pressures and temperatures, and extreme thermal variations.

The transfer vapor line pipe illustrated above is a recent example of special piping for refinery service fabricated in the Kellogg shops.

Whether you require piping for a single unit or an entire piping system a Kellogg engineer will gladly assist you.

THE M. W. KELLOGG COMPANY · JERSEY CITY, NEW JERSEY · 225 BROADWAY, NEW YORK

REPRESENTATIVES

Los Angeles: 1031 South Broadway **Houston, Texas**
Chicago: 122 South Michigan Avenue **Tulsa: Philtower Building**

KELLOGG

"Masterweld" pressure vessels for the Power, Refinery and Chemical Industries. Power Plant and Industrial piping. Heat Exchangers, Radial Brick Chimneys, Plastic Refractories. Cross, Holmes-Manley, de Florez and Tube and Tank cracking units. Gas Polymerization Units. Deasphalting, Dewaxing, Solvent Extraction, Acid Treating Plants, Absorption Plants and Pipe Stills.

for identification of structure of a pure hydrocarbon and give new evidence as to the energy relationships of the carbon-carbon double bond.

Raman Spectra of the Nine Heptanes and Their Use in the Identification of Heptanes in Mixtures. E. J. ROSENBAUM, A. V. GROSSE, AND H. F. JACOBSON, *University of Chicago and Universal Oil Products Company.*

The Raman spectra of pure samples of the nine isomeric heptanes were photographed with a three-prism spectrograph of moderately high dispersion (10 A°/mm. at 4400A°). Each of the spectra has characteristic features which make possible an unambiguous identification and a reliable semi-quantitative analysis of mixtures.

Earlier results on hexanes proved the reliability of the Raman method by checks against chemical methods of identification and analysis (Br or $-NO_2$ derivatives). With the heptanes no such comparison is possible because of the large number of derivatives involved. However, the examination of mixtures made from the pure samples indicates the value and limits of this application of Raman spectra.

The unknown mixtures of paraffins examined were obtained by the catalytic alkylation of isobutane with propylene in the presence of BF_3 or $AlCl_3$. The heptane fraction was separated into close-boiling cuts by a 100-plate Bruun column. The bulk of the heptanes concentrated in the two following cuts: Cut A, boiling at 78.5 to 80.5° C. and Cut B, 84.5 to 86.5° C. at 760 mm. Cut A was identified as Raman-pure 2,4-dimethylpentane, whereas Cut B proved to be Raman-pure 2,3-dimethylpentane.

Surface Tension of the Hydrocarbons. DONALD L. KATZ AND WILLIAM SALTMAN, *University of Michigan.*

Data on the surface tension of ethane, propane, and *n*-butane under their vapor pressures from 0 to 40° C. are reported. These data and those of the literature have been correlated to give surface tensions for normal paraffins, ethane through octane from 0° C. to the critical temperature. The presentation of a surface tension-reduced temperature plot and a discussion of the possibility of using surface tension measurements as criterion for critical temperatures of petroleum hydrocarbons are included.

The Vapor Pressures of the *cis* and *trans* Isomers of Decahydronaphthalene. W. F. SEYER AND HERMAN NEMETZ.

The static method was used for determining the vapor pressures of these isomers. Regular vapor pressure curves were obtained when the pressure was plotted against the temperature. Plotting log pressure against the reciprocal of the absolute temperature gave a straight line for the *cis* isomer and two straight lines for the *trans*. This indicates two forms for the *trans* isomer, and thus these results favor the existence of more than two isomers for the hydrocarbon, decahydronaphthalene.

The Density and Transaction Points of Dicetyl ($C_{32}H_{66}$), W. F. SEYER AND WM. MORRIS.

Two samples of dicetyl were synthesized from cetyl alcohol by conversion to the iodide followed by the addition of sodium. Fractional crystallization from glacial acetic acid and ether was used for purification.

The densities over the range zero to 90° C. of these two samples and of one sample obtained from the Eastman Kodak Company were measured by the dilatometric method.

Curves showing the density against temperature have two definite breaks indicating changes in the crystalline form, the transition points being 63.5° and 69.5° C. The melting point of the two samples of dicetyl prepared in this laboratory was found to be 69.6° C.

Piper and his co-workers determined the transition and melting points of the series of paraffins from $C_{26}H_{54}$ to $C_{36}H_{74}$ by observing the changes in the physical appearance of the sample in a melting point apparatus as the temperature was raised or lowered. At the transition point a decided change in the appearance of the paraffin can be noted, but, since the change is rather slow, the dilatometric method using accurate temperature control is seen to be more accurate.

The melting point (69.6° C.) and the upper transition point (69.5° C.) agree with those of Piper. When his lower transition temperatures on cooling are plotted against the number of carbon atoms in the paraffin, the transition point of dicetyl from density measurements lies on the straight line through the points.

The agreement in these temperatures indicate that dicetyl of a high degree of

Since World War Days

The Sharples Petroleum Research Plant will soon be "of age"—21 years. When it was built, "low cold test bright stock" meant a pour point of 45°F. Do you remember? First 25°F., later 0°F., cold test bright stocks were born in this Research Plant—and later, Sharples centrifugal acid treating of lubricating stocks and the treating of white oils with fuming acid—and Barisol dewaxing for crystalline stocks—and a dozen other applications. And this is important—the keen magician who started this Research Plant still directs its destinies. That means something to one tired of working with amateurs.

The Sharples Specialty Co.
2335 Westmoreland St. Phila., Pa.

purity can be synthesized from cetyl alcohol.

The shape of the density temperature curve shows that dicetyl crystallizes just below the melting point with the chain axis normal to the basal plane and that two forms of lower symmetry in which the chain axis is not vertical exist at lower temperatures.

Determination of Gasoline Unsaturation by Vapor Phase Hydrogenation. R. D. PINKERTON, A. K. ROEBUCK, AND S. J. WAYO, *Sinclair Refining Company.*

A routine method applicable to normally liquid aliphatic hydrocarbon mixtures within the gasoline boiling range but containing no hydrocarbons lower than C_6 is described. Analysis of pure hydrocarbons and hydrocarbon mixtures indicates an accuracy of 3 percent. Hydrogenation is carried on in the vapor phase. The sample, in a current of hydrogen, is passed dropwise into the bottom of a combination vaporization and catalyst chamber maintained at 400° F. The hydrogen-hydrocarbon mixture passes upward through the catalyst, which is reduced nickel on asbestos. The hydrogen and hydrocarbon are separated by condensation of the latter, each is collected in a suitable receiver, and the contraction in hydrogen volume is determined. This cycle is repeated until hydrogenation is complete, as indicated by a constant hydrogen volume. The molecular weight of the sample as determined and the mole percent of hydrogenation is then calculated. Hydrogenation is complete in about 4 to 6 cycles, and the entire analysis requires 3 to 3½ hours. Only 3 to 4 cc. of sample are required. A diagram and description of the apparatus are included.

Systematic Distillation of a Dewaxed Lubricant Fraction of a Mid-Continent Petroleum Preliminary to Isolating Its Constituents. A Continuous High-Vacuum Still and Apparatus for Determining Boiling Points at Low Pressures. R. T. LESLIE AND W. W. HEUER, *National Bureau of Standards.*

A sample of lubricant stock having about the properties of 20 W lubricating oil was obtained from a refinery supplied with crude oil from the Oklahoma City field. Two hundred forty gallons were distilled through a semi-commercial vacuum still. A continuous high-vacuum laboratory still and an apparatus for determining boiling points were constructed. The material was distilled systematically three times. After the third distillation, there remained 762 kg. of material which distilled between 135° and 270° C./1 mm. Hg. There appear four large concentrations in volume. The results of the distillation of the lubricant fraction and of the naphtha fraction from a Ponca City petroleum are compared at the same stages.

Exhaustive Fractionation, by Distillation and Extraction, of the "Extract" Portion of the Lubricant Fraction From a Mid-Continent Petroleum. BEVERIDGE J. MAIR AND CHARLES B. WILLINGHAM.

This paper describes the separation, by distillation and extraction, of the "extract" portion of the lubricant fraction from a Mid-Continent petroleum. After a preliminary separation of the "asphaltic" material, the remainder of the sulfur dioxide-soluble material and the silica gel "hold-up" were combined and systematically distilled until substantially constant - boiling fractions were obtained. Five charges of these fractions with narrow-boiling ranges were then prepared and each charge of from 500 to 700 grams was separated into 30 to 40 fractions by reflux extraction with methyl cyanide, or methyl cyanide containing acetone, in 16.7-m. columns. Kinematic viscosities at 100° and 210° F., refractive indices, densities, refractive dispersions, specific optical rotations, and aniline points were determined for most of the fractions from the extraction process. In addition for 41 "key" fractions there are reported boiling points, molecular weights, and carbon-hydrogen ratios, and for some of these fractions there are given the percentages of sulfur, nitrogen, and oxygen. Attention is called to a number of interesting facts in connection with the properties of these petroleum fractions.

The Hydrogenation of Fractions Prepared by Extensive Separation of the "Extract" Portion of the Lubricant Fraction From a Mid-Continent Petroleum. BEVERIDGE J. MAIR, CHARLES B. WILLINGHAM, AND ANTON J. STREIFF.

To obtain information about the chemical constitution of the "extract" portion of the lubricant fraction from a Mid-Continent petroleum, fifteen selected fractions, prepared by extensive distillation and extraction, were completely hydrogenated. The hydrogenation procedure is described and there are tabulated and compared values for the physical constants of the fractions

Don't Junk 'Em—

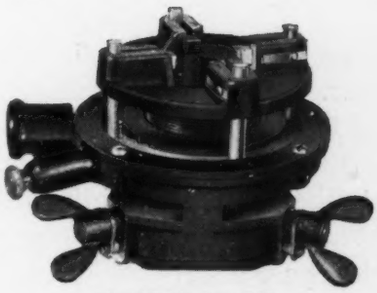
Trade them in on new "Toledo" Super Threaders

We offer you a liberal trade-in allowance on old "TOLEDO" No. 1 or 1A tool bodies on the purchase of new "TOLEDO" No. 1BR tool bodies and old "TOLEDO" No. 2 tool bodies on the purchase of new "TOLEDO" No. 2BR tool bodies.

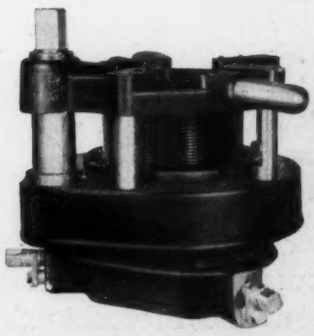
No bushings. No cams. Long jaws. Big grip. Easy centering. Simple. Strong. Dependable.

Use your regular No. 1 and No. 1A dies and handles in the No. 1BR bodies, and No. 2 dies and ratchet handles with No. 2BR bodies. This is your opportunity to cash in on your old tools and modernize your tool equipment at a saving.

Write for further details or see your dealer.



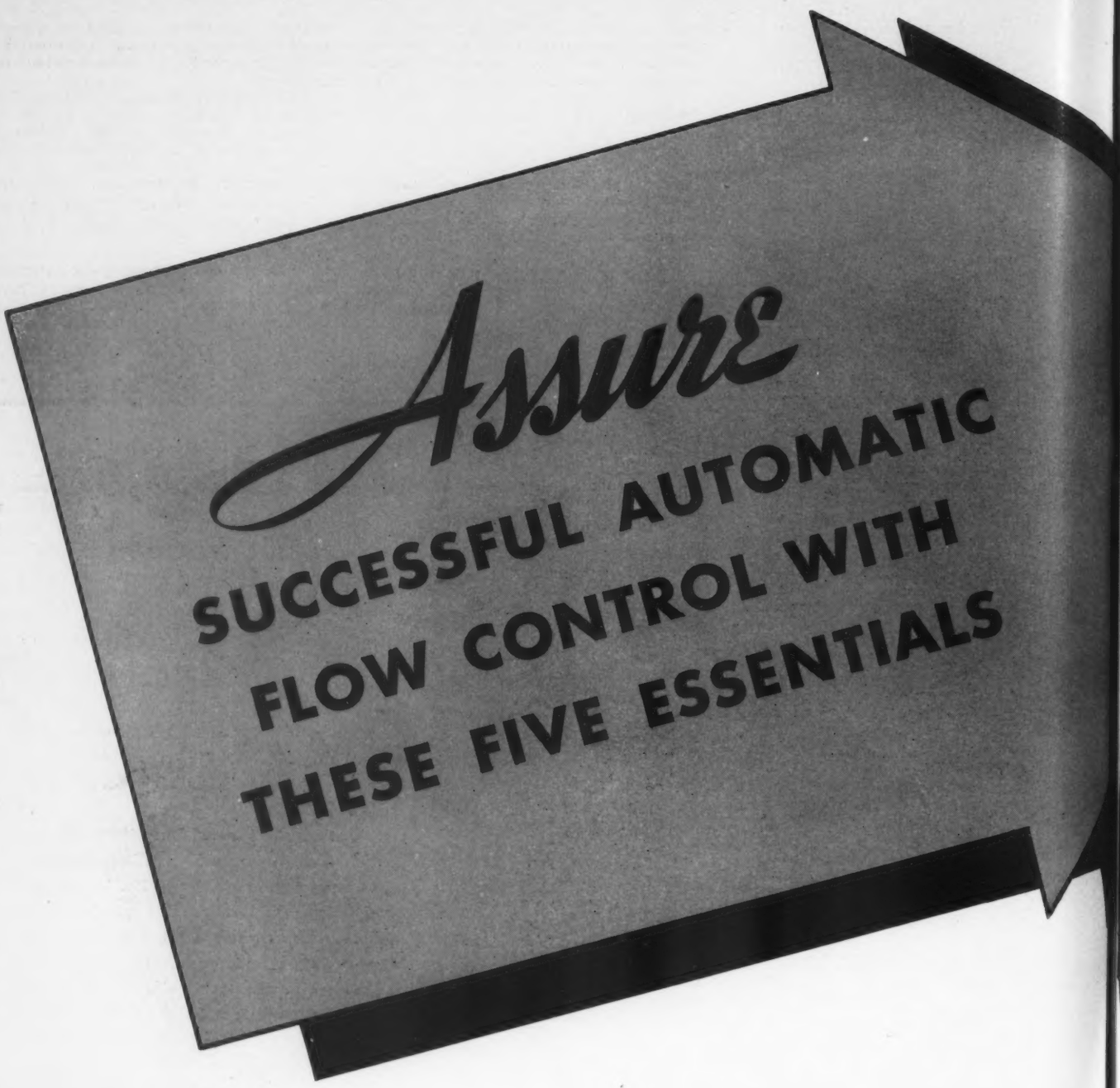
"TOLEDO" No. 1BR
1" to 2" Ratchet



"TOLEDO" No. 2BR
2½" to 4" Geared Ratchet

THE TOLEDO PIPE THREADING MACHINE COMPANY
TOLEDO, OHIO New York Office, 72 Lafayette Street

"TOLEDO"
TRADE-MARK REGISTERED U.S. PAT. OFFICE



A FLOW CONTROLLER can be no better than its Flow Meter. Foxboro long has recognized this and attributed much of the success of the Foxboro Flow Controller to the proved accuracy and dependability of the Foxboro Meter. This, in combination with the 4 other essential factors, has made for the outstanding success of these Controllers over a period of 15 years in thousands of installations.

All of the features of Foxboro Flow Control are described in detail in the new Bulletin 170—1. Many typical examples of the profitable application of Flow Control are illustrated and described for both compressible and non-compressible fluids. This bulletin is most complete and of practical value to every engineer who handles flow.

Write for a copy of this bulletin and learn the simplicity of dependable automatic control of flow. The service of our engineers is freely offered in solving any of your Flow Control problems. The Foxboro Company, 74 Neponset Avenue, Foxboro, Mass. Branch Offices in 25 Principal Cities.

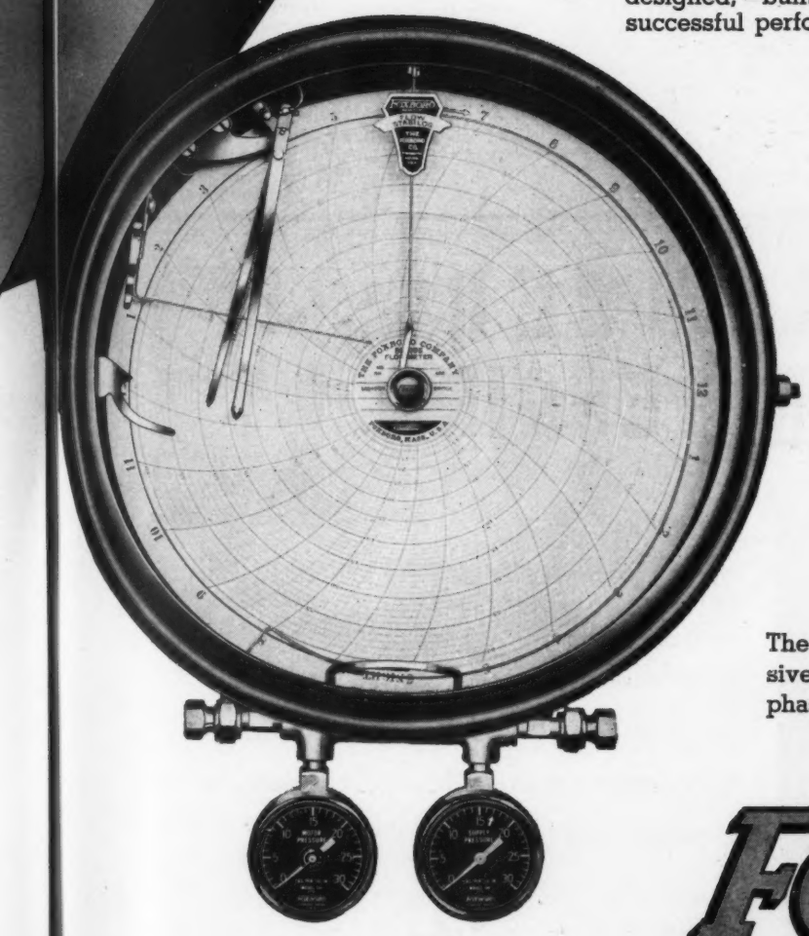
1. **Inherently Accurate Flow Meter.** Foxboro straightline principle eliminates all inherent error caused by angularity of movement. It has proved simple and lastingly accurate, with the lowest maintenance cost.

2. **Stabilog System of Control.** This was the first instrument to have automatic reset, and was first developed for Flow Control. The Stabilog Controller has every essential for 100% automatic control. It has been in successful use for 9 years.

3. **Correctly-Designed Stabilflo-Controlled Valves.** These valves were designed for use with air-operated control instruments. They have the correct flow characteristics to assure the inherently smooth, close control of the Stabilog system.

4. **Sound Engineering Experience.** 15 years of Flow Control . . . backed by 21 years of automatic control engineering and 25 years of successful flow engineering as one of the leading meter manufacturers . . . have given The Foxboro Company the only extensive experience in flow control problems.

5. **Unified Manufacturing Responsibility.** These Controllers are 100% Foxboro-designed, —built and —serviced. The responsibility and assurance of successful performance are undivided.



The new Flow Control Bulletin 170—1 gives a comprehensive, up-to-the-minute description of Flow Control, emphasizing application information. Write for a copy.

FOXBORO

Reg. U. S. Pat. Off.

STABILOG FLOW CONTROL

before and after hydrogenation. Evidence is presented to show that, under the conditions of these experiments, namely temperatures from 230° to 250° C. and pressures of hydrogen from 170 to 210 atmospheres, the fractions were completely hydrogenated and that no breakdown of the molecules occurred.

The Chemical Constitution and Physical Properties of the "Extract" Portion of the Lubricant Fraction From a Mid-Continent Petroleum. BEVERIDGE J. MAIR, CHARLES B. WILLINGHAM, AND ANTON J. STREIFF.

A correlation has been made of the properties of 179 fractions of oil prepared by extensive distillation and extraction of the "extract" portion of the lubricant fraction from a Mid-Continent petroleum. The correlation includes a comparison of the properties of these fractions with those of a selected 15 of the same fractions after complete hydrogenation, with those of synthetic hydrocarbons of high molecular weight, and with those of fractions of water-white oil previously prepared from this same lubricant fraction.

The following physical and chemical properties have been compared: specific optical dispersion, specific optical refraction, specific optical rotation, aniline point, viscosity at 100° to 210° F., kinematic viscosity index, and boiling point at 1 mm. Hg. The sulfur, oxygen, and nitrogen content and the value of x in the expression C_nH_{2n+x} have also been considered.

Conclusions are drawn concerning the chemical constitution of the entire lubricant fraction exclusive of the "wax" and the "asphaltic" material.

▼ PLANT ACTIVITIES ▼

Refinery: North Star Navigation Company, Stockholm, Sweden, plans to start a new refinery of 5000 to 7500 barrels capacity which is to be constructed at a reported cost of $1,750,000. The company operates the only refinery in Sweden and the new plant will be erected on the site of the present works, near Stockholm.

Phenol: Humble Oil & Refining Company started construction early this month of a new phenol solvent plant for production of lubricating oils at its Baytown, Texas, plant. Contract to M. W. Kellogg Company.

Repressuring Plant: Corpus Christi Corporation, Corpus Christi, Texas, which recently took over the John F. Camp holdings in the Stratton field, western Nueces County, has been granted permit by the Texas Railroad Commission to erect a gasoline extraction-gas recycling repressuring plant. The company has given contract to Stearns Rogers Manufacturing Company, Parkhill-Wade, Inc., for construction of the gas recycling plant which is to be erected at reported cost of $500,000. Daily capacity is 50,000,000 cubic feet.

Repressuring: J. Wood Glass, Corpus Christi, has received permit from the Texas Railroad Commission for construction of a gas recycling-gasoline extraction and repressuring plant in the Agua Dulce field, Nueces County, Texas. Gas will be processed and returned to producing horizon.

Repressuring: F. C. and E. P. Henderson have been granted permit applying to wells producing sweet gas, for a plant in Hutchinson County, Texas Panhandle, which will process gas from one horizon and return it to oil producing formations.

Repressuring: Champlin, Bass & Patton Company, Long Lake field, Anderson County, Texas, have been granted permit by the Texas Railroad Commission for installation of a recycling type of gasoline extraction and repressuring plant, which will process the gas and return it to the same producing horizon.

Gasoline: Continental Oil Company has started operating the first of the three natural gasoline plants being erected in the K-M-A field, near Wichita Falls, Texas, with the remaining plants scheduled for early completion. The three-plant system is designed to process gas from the entire producing area of the field, and includes provision for return of the gas to the various leases at pressure sufficiently great to permit repressuring, an important conservation measure. All three plants are being equipped with 400-horsepower angle-type compressor units, each capable of taking 2,000,000 cubic feet of gas from below atmospheric pressure to pressures ranging from 250 pounds to 2000 pounds per square inch. It is said that about 1600 pounds will be required for repressuring the producing horizon. Under present restricted flow in the field production from the plants

MAXIM SILENCERS WILL QUIET ANY ENGINE

THESE MODEL DO4 MAXIM SILENCERS REDUCE EXHAUST NOISE TO A WHISPER

Wherever you find engines, you will find MAXIM SILENCERS. The wide variety of models permits selection of **exactly** the correct type for your engine, be it gas, Diesel, steam, or gasoline. Insist on MAXIM and be assured of a noise-free installation.

The
MAXIM SILENCER COMPANY
HARTFORD, CONN. DALLAS, TEX.

is expected to total about 15,000 gallons of gasoline a day, but the system has a daily capacity of 40,000 gallons.

Combination: Socony-Vacuum Oil Company, White Star Division, Trenton, Michigan, is building a new 20,000 barrel combination type cracking unit.

Poly Plant: Roosevelt Refining Company, Mount Pleasant, Michigan, is reported planning addition of a polymerization plant. The company recently completed a 1250-barrel cracking unit and an Ethyl blending plant.

Refinery: McColl-Frontenac Oil Company, Toronto, Ontario, Canada, is mentioned in reports as planning establishment of a new $1,000,000 refinery, skimming and cracking, 2000 barrels per day capacity, possibly at Calgary, Alberta. The Texas Corporation recently acquired a substantial interest in the McColl-Frontenac Oil Company. Other reports state that the company has been drawing plans for a refinery at Regina, Saskatchewan, with estimated cost of $500,000.

Addition: Barber Asphalt Company, Barber, N. J., has awarded contract to Carlson Company for an addition to its asphalt plant, with estimated cost reported at $165,000.

Refinery: Inland Empire Refineries, Spokane, Washington, Emby Kaye, manager, has awarded contract to Winkler Koch Engineering Company for construction of a refinery to process 2200 barrels of crude daily.

Gas: Puergas, Ltd., Port Hope, Ontario, Canada, is preparing plans for construction of a plant for manufacture of liquefied petroleum gases. Reported cost is $40,000.

Refinery: Les Huilles Union, Ltd., Quebec City, Quebec, Canada, is reported planning construction of a small refinery to be erected at an estimated cost of $40,000.

Refinery: B. V. Hole, Cut Bank, Montana, is building a topping plant at Spokane, Washington, to operate on Cut Bank crude. Plant capacity is reported at 500 barrels.

Operating: Worth Refining Company, Inc., Chicago, Illinois, has started operating its newly completed 1500-barrel topping plant at Blue Island, Illinois.

Purchase: Dr. Sidney Born and W. C. Berry have purchased from the receiver, Frank Porter, the 4000-barrel skimming plant at Ardmore, Oklahoma, last operated by Wirt Franklin Petroleum Corporation. Plans are to recondition and begin operating soon.

Gasoline Plant: Union Oil Company and Superior Oil Company have started operating the jointly owned natural gasoline plant near Shafter, Kern County, California, processing gas from the Rio Bravo field. Plant capacity is 20,000,000 cubic feet daily. Union Oil Company is the operator.

Repairs: Sinclair Refining Company is repairing the lubricating oil dewaxing plant and auxiliary equipment at Wellsville, New York, damaged recently by fire. Other units damaged have been repaired and returned to operation. Estimated cost is $100,000.

Solvent Plant: Union Oil Company of California has given contract to the Bechtel-McCone-Parsons Corporation for construction of its new phenol-solvent lubricating oil plant at the company's Oleum refinery. Construction has started.

Refinery: The Cargo Oil Company of Texas has started construction of a skimming plant in the K-M-A field, Texas, with a capacity of 1500 barrels per day. John Golden is president.

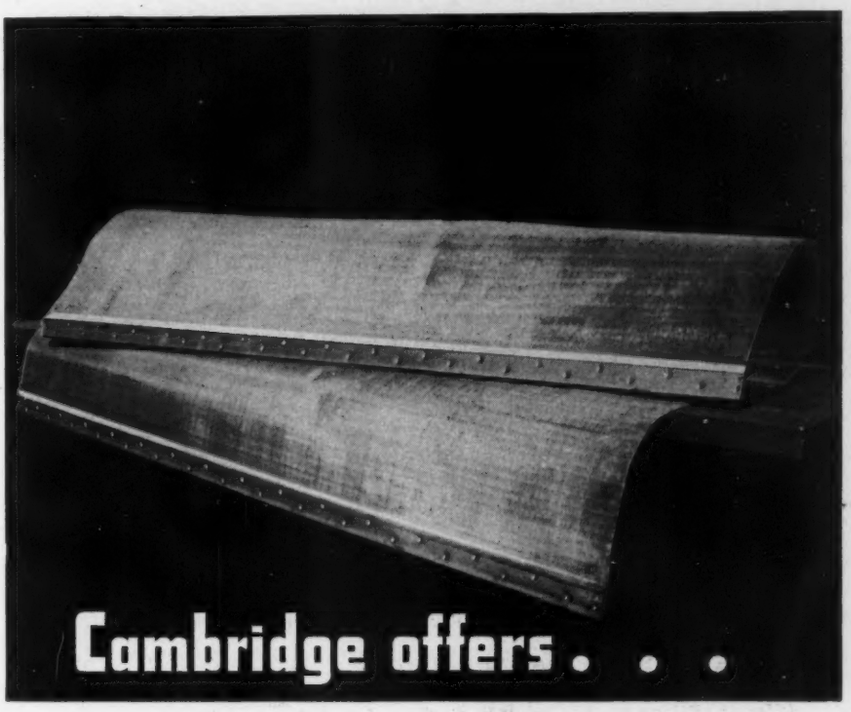
Resume: Taxman Refining Company, Wichita Falls, is reported planning construction of a pipe line from the K-M-A field to Wichita Falls and to resume operations of its skimming and cracking type refinery.

Grease Institute Meeting

THE National Lubricating Grease Institute will hold its sixth annual cenvention at the Stevens Hotel, Chicago, October 3 and 4.

In conjunction with the convention there will be an exhibition of equipment by associate members.

Arrangements have been made to present a number of papers by nationally known engineers on grease manufacture, application and grease dispensing equipment.



New, Money-Saving
Screen Cloth

RECENTLY developed after extensive research, this Mud Screen Cloth is metallic hook bound, rubber cushioned. It is particularly designed for use on standard type shakers for reclaiming and conditioning rotary drilling mud.

Cambridge manufactures Wire Screens for use in all type screens. They are uniformly high in quality due to systematic and accurate control of every step of manufacture, in our own plant. They cost less, hundreds in use have proved they save you money in production. For information, consult the Cambridge engineer in your territory or write us.

CAMBRIDGE WIRE CLOTH CO.
CAMBRIDGE, MARYLAND
Boston · New York · Baltimore · Pittsburgh · Detroit · Chicago · San Francisco · New Orleans

SCIENCE AND TECHNOLOGY

Abstracts prepared in co-operation with the

REFINER AND NATURAL GASOLINE MANUFACTURER

by

THE LESLIE LABORATORIES

Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

The Molal Heat of Organic Vapors, K. BENNEWITZ AND W. ROSSNER, *Z. Physik. Chem.* **B39** (1938) pp. 126-44.

The heat capacity of organic vapors was studied by means of a streaming method similar to that of Scheel and Heuse. A method for the determination of heat of vaporization is also described. The heat-capacity apparatus was tested by determining the specific heats of air, carbon dioxide and hydrogen, and the apparatus for heat of vaporization was tested by using benzene, acetone, and ethyl-alcohol. Measurements of the properties of the following compounds were made: benzene, toluene, cyclohexane, methyl-cyclohexane, acetone, methyl-ethyl-ketone, n-pentane, n-hexane, n-heptane, ethyl alcohol, propyl alcohol, iso-propyl alcohol, butyl alcohol, iso-butyl alcohol, metyhl acetate, ethyl acetate, ethyl propionate and iso-butyl acetate. An approximate formula similar to that of Kopp and Neumann was derived for the calculation of specific heat at any given temperature. A semi-empirical formula was also derived for calculation at any temperature. The latter is based on valence and deformation frequencies determined from the vibrational infrared or Raman spectra. The temperature coefficient of specific heat can also be determined as a first approximation over a limited temperature range. The agreement between experimentally determined and calculated values is good.

Viscosity of Hydrocarbon Solutions, B. H. SAGE AND W. N. LACEY, *Ind. & Eng. Chem.* **30** (1938) pp. 829-34.

Until recently the influence of pressure upon the viscosity of hydrocarbon gases has received little attention, but the investigation reported indicates that the effect of pressure may be as great as that of temperature within the range of conditions encountered in petroleum production. Because of the scarcity of this type of information a study was made of the effect of pressure and temperature upon the viscosity of liquid and gaseous propane. The data reported cover the single-phase regions from atmospheric pressure to 2000 pounds per square inch at temperatures from 100° to 220°F. Data are presented in tabular and graphical form, and a bibliography of 28 references is given.

The Viscosities of Hydrocarbons, Parts IV-VI, E. B. EVANS, *Jour. Inst. Pet. Tech.* **24** (1938) pp. 321-37.

In previous papers the author has covered the general scope of the investigation, has considered small viscometers used for measuring hydrocarbon viscosities, and has discussed the viscosities of the normal paraffin hydrocarbons. On thirteen of these hydrocarbons there exist data sufficiently reliable and extensive to enable absolute and kinematic viscosities to be tabulated, showing, in most instances, values over the temperature range 0°C to 100°C. In Part IV of the present paper data on the isoparaffin hydrocarbons are given, of which eighteen have been sufficiently well examined to permit tabulation. The monocyclic napthenes studied include twenty-one cyclopentane and cyclohexane derivatives with from five to thirty-two carbon atoms. Fourteen cyclopentane and cyclohexane hydrocarbons have been examined as well as four long-chain cyclohexane derivatives for which data were given by Mikeska. In the data on the acyclic olefines there are included the earlier results of Thorpe and Rodger, as well as measurements on three hydrocarbons that have not previously been examined for viscosity. The present knowledge of the viscosities of the olefines of higher molecular weight is largely due to the work of Lerer, and particularly to that of Landa and his collaborators. The work of the latter is noteworthy because of the completeness of the data, including viscosity measurements of 10°C intervals, and full data on density and other physical properties. Viscosities of few of the cyclic olefines are available, only singe measurements on about ten of these hydrocarbons exist. For cyclohexene, however, results extend from 5°C. to 75°C.

Spontaneous Ignition Under Pressure of Typical Knocking and Anti-Knocking Fuels, M. MACCORMAC AND D. T. A. TOWNEND, *J. Chem. Soc.* (1938) pp. 238-46.

Previous investigations of spontaneous ignition have been extended to include observations on some of the newer anti-knock fuels, namely iso-octan diisopropyl ether and acetone. It was found that much higher pressures are necessary for the spontaneous ignition of side-chain paraffins than for the straight-chain isomers. However, the temperature ranges in which cool flames are observed, and the character of the low-temperature ignition systems induced thereby are much the same in both cases. The cool flame zones on the systems of lower ignition point of the ethers seem to be composite. Much higher pressures are required for the ignition of mixtures of air with diisopropyl ether than for diethyl ether. Results are presented graphically. The author suggests a procedure whereby the relative knock-rating of a fuel can be determined from the characteristics of spontaneous ignition under pressure.

Calculation of Calorific Powers of Hydrocarbons, M. BRUTZCUS, *Compt. Rend.* **206** (1938) pp. 1291-4.

From the results obtained in previous work a series of formulas for the calculations of heat of combustions of the various hydrocarbon series are deduced. The heat of combustion (P) for the paraffins is given by the equation, $P = 156.9m + 58.3$ kg. Cal. For the olefins, $P = 156.9m + 22.6$ kg. Cal. Calculated values are compared with experimentally determined data.

Solubility of Refined Paraffin Waxes in Petroleum Fractions, A. BERNE-ALLEN, JR. AND L. T. WORK, *Ind. & Eng. Chem.* **30** (1938) pp. 806-12.

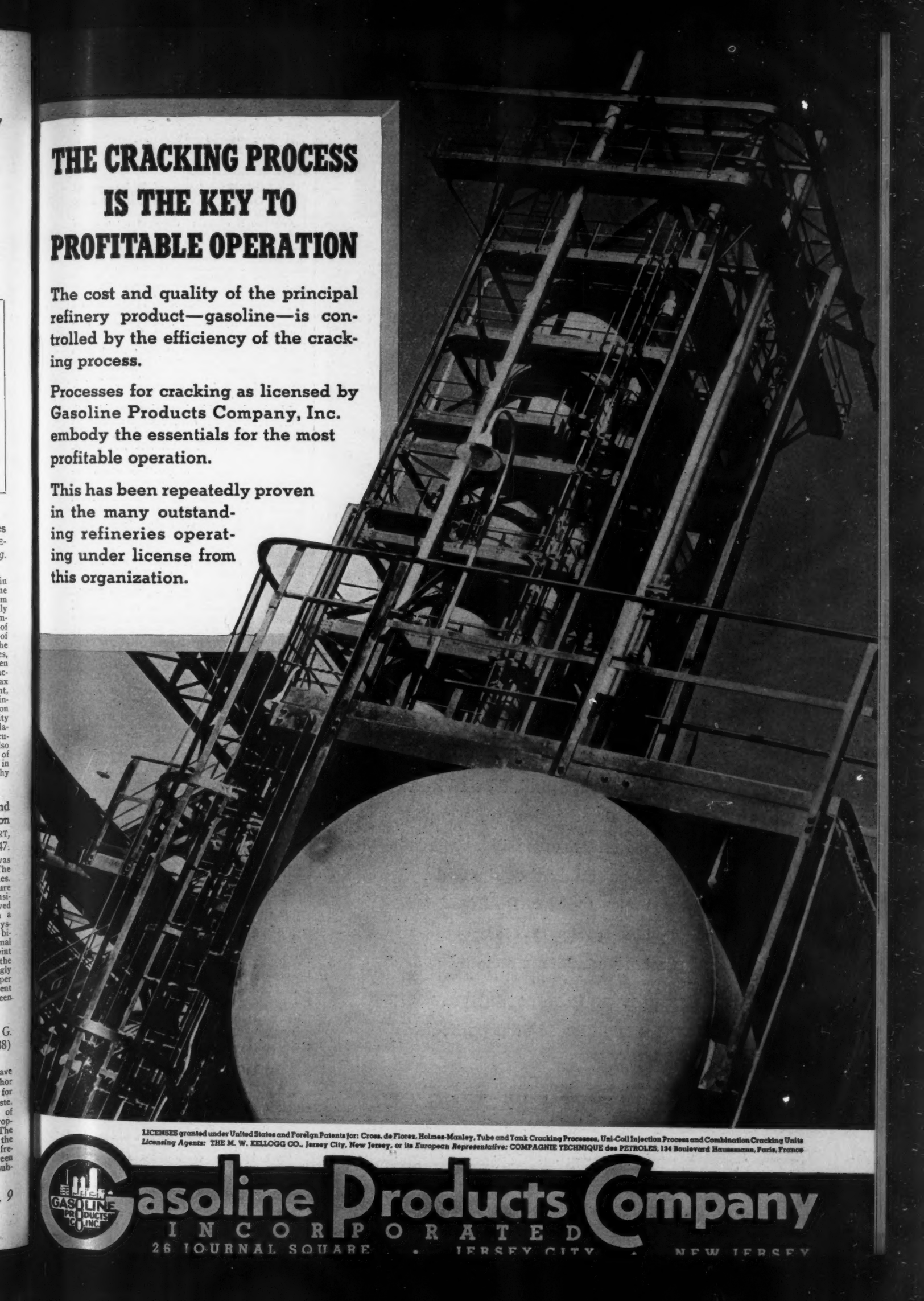
Solubility of commercially refined paraffin waxes in petroleum distillates was studied. The wax samples used as solutes and the petroleum distillates employed as solvents were carefully identified by laboratory inspections. It was demonstrated that the average boiling points of petroleum fractions and the melting points of the paraffin waxes are directly related to the molecular weights of the solvents and solutes, respectively. Quantitative relationships between paraffin wax solubilities in the petroleum fractions and the following variables: paraffin wax melting point, average boiling point of solvent, and solution equilibrium temperature—were intensively investigated. An empirical equation was established to express paraffin wax solubility in petroleum fractions in terms of these relationships. The effect of changes in the molecular structure of hydrocarbon solvents was also considered, and the concept of a coefficient of solubility discussed. The data are presented in tabular and graphical form, and a bibliography of eleven references is included.

Crystal Twins of Normal $C_{24}H_{50}$ and the Influence of Phase Transitions on Their Orientation, E. C. H. KOLVOORT, *Jour. Inst. Pet. Tech.* **24** (1938) pp. 338-47.

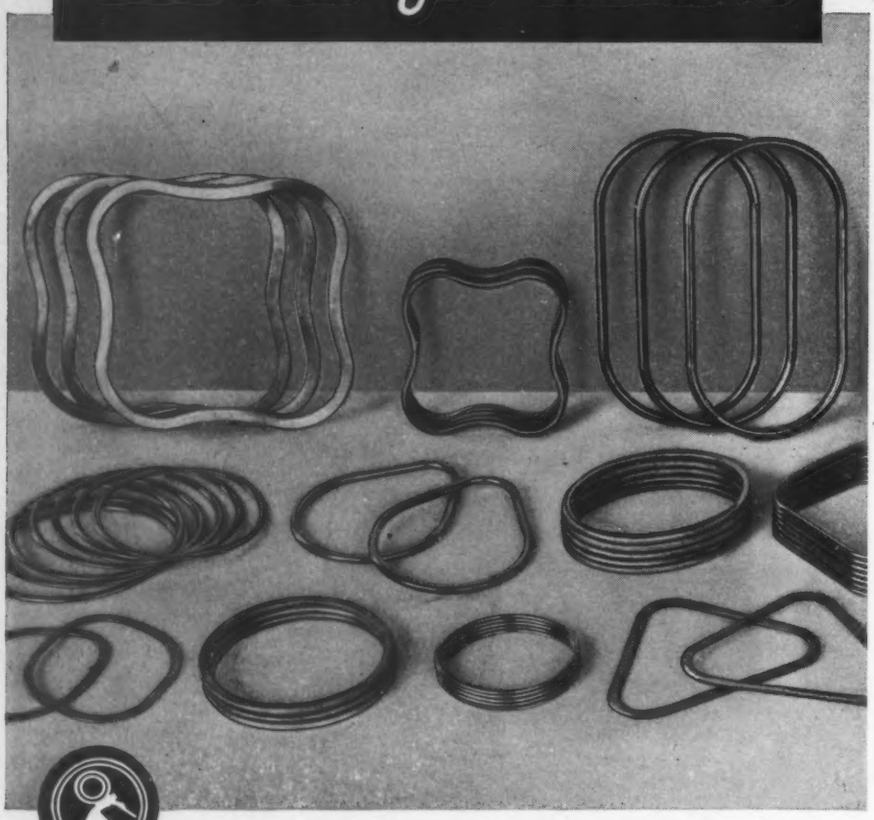
The crystal structure of normal $C_{24}H_{50}$ was studied, particularly the twin structure. The (110) and (310) planes act as twinning planes. $C_{24}H_{50}$ is optically positive at room temperature and is biaxial. At 41°C. and at 46°C. transitions into a different solid phase were observed when studying pure synthetic n-$C_{24}H_{50}$ with a setting point of 50.8°C. Above 46°C. the crystals were optically uniaxial, with positive birefringence, and were probably of the hexagonal system. Between 41°C. and the melting point the crystals were soft. It was found that the lower point of transition was more strongly decreased by contaminations than the upper point. The article includes twenty excellent micro-photographs. A bibliography of fourteen references is included.

The Scientific Basis of Odour, G. MALCOLM DYSON, *Chem. & Ind.* **57** (1938) pp. 647-51.

Odour and taste are two properties that have defied quantitative measurement. The author describes the mechanism developed in man for the perception of sensations of odour and taste. He is of the opinion that the perception of these sensations depends upon a physical property of the molecules that is peculiar. The molecular vibration that is susceptible to the osmic sensory system, he terms the osmic frequency. A relationship has been found between Raman spectra and osmic frequency. The sub-


THE CRACKING PROCESS
IS THE KEY TO
PROFITABLE OPERATION
The cost and quality of the principal refinery product—gasoline—is controlled by the efficiency of the cracking process.
Processes for cracking as licensed by Gasoline Products Company, Inc. embody the essentials for the most profitable operation.
This has been repeatedly proven in the many outstanding refineries operating under license from this organization.
LICENSES granted under United States and Foreign Patents for: Cross, de Florez, Holmes-Manley, Tube and Tank Cracking Processes, Uni-Coil Injection Process and Combination Cracking Units
Licensing Agents: THE M. W. KELLOGG CO., Jersey City, New Jersey, or its European Representative: COMPAGNIE TECHNIQUE des PETROLES, 134 Boulevard Haussmann, Paris, France
GASOLINE PRODUCTS CO. INC.
Gasoline Products Company
INCORPORATED
26 JOURNAL SQUARE • JERSEY CITY • NEW JERSEY

GOETZE for GASKETS



BOILER GASKETS

Many types . . . Metal Jacketed, Corrugated, Serrated, Spiral Wound and Woven, for hand holes, tube caps, man holes, headers and boiler casings . . . as used as standard equipment by leading boiler makers. Designed for each specific service and temperature and pressure conditions encountered.

Large stocks. Prompt deliveries. Intelligent attention to your particular requirements.

GOETZE GASKET & PACKING CO. INC.

8 Allen Ave. New Brunswick, N. J.

ject is discussed and developed in an interesting manner.

Chemical Compositions and Reactions

Probable Structures of Polymers of Lower Olefins, A. WACHTER, *Ind. & Eng. Chem.* **30** (1938) pp. 822-6.

Attention is called to the need for a set of working rules that will enable a fairly reliable prediction of the nature of polymers from olefins. An account of rather extensive work in this general field is now more possible to test the applicability and usefulness of many methods of predicting polymer structure. The author proposes working rules for predicting the catalytic polymerization products of acyclic olefins. These rules are based upon the assumption of a mechanism in which a hydrogen atom and an unsaturated alkyl radical from one olefin molecule saturate the double bond of another olefin molecule. Consideration is given to the possibilities of rearrangement of the original olefin before, and of the primary polymer after, polymerization. Comparisons are made showing satisfactory agreement between the structures predicted and those found experimentally.

Mechanism of Polymerization. Part 2. Dimerization of Dimethylbutadiene in Presence of an Acid Catalyst, E. H. FARMER AND R. C. PITKETHLY, *J. Chem. Soc.* (1938) pp. 11-19.

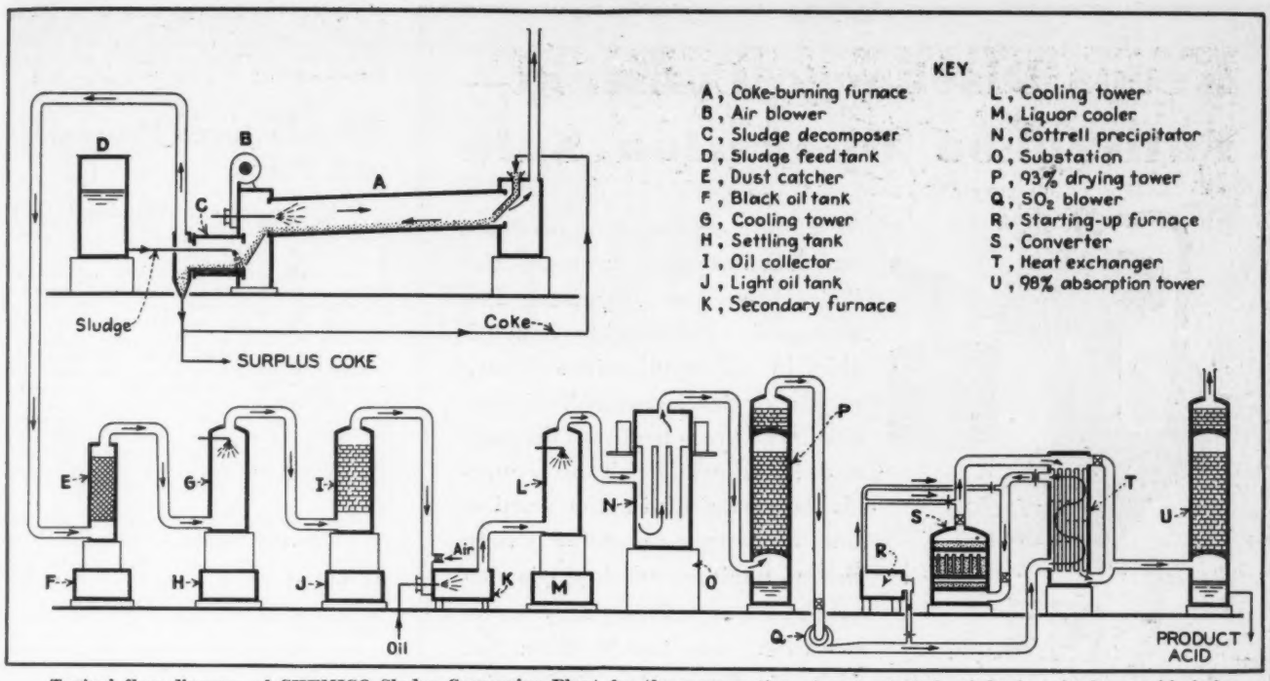
The polymerization of $\beta\gamma$-dimethylbutadiene by sulphuric acid dissolved in acetic acid gives dimeric, trimeric and other low molecular weight products. The nature of the product varies somewhat with experimental conditions. The dimeric product is composed mainly of a monocyclic (cyclohexenic) hydrocarbon. Under other conditions, a dicyclic-dimeride is also formed. The cyclohexenic dimeride is identical with that that has frequently been obtained by the action of heat on $\beta\gamma$-dimethylbutadiene, and the authors have synthesized this dimeride.

Saturated High Octane Fuels Without Hydrogenation. The Addition of Olefines to Isoparaffins in the Presence of Sulphuric Acid, S. F. BIRCH, A. E. DUNSTAN, F. A. FIDLER, F. B. PIM, AND T. TAIT, *Jour. Inst. Pet. Tech.* **24** (1938) pp. 303-20.

The authors briefly review the subject of the high octane fuels, and discuss the advantages of isoparaffinic types of fuel, and the methods that have been used in making this type of fuel. The production of isooctane by the direct combination of isobutene with isobutane is a particularly attractive problem because the use of such a reaction would increase the potential supply of isooctane, would eliminate the necessity for hydrogenation, and at the same time would find a use for isobutane, a hydrocarbon that at present has little more than fuel value. The authors have found that isobutene and isobutane react readily at ordinary temperatures in the presence of sulfuric acid to give a product consisting essentially of isoparaffins of high octane rating and containing a high proportion of iso-octanes. It has become increasingly obvious that isoparaffins are far more reactive than the corresponding normal members of the series, and that the increased activity centers around the tertiary carbon atoms. Investigation has shown that the reaction between isoparaffins and olefines is general in character. Of the isoparaffins so far examined, isobutane, isopentane, and isohexane were found to react readily, although iso-octane failed to react. The olefines studied included propylene, butene-1, butene-2, isobutene, and its di- and tri-merides, trimethylethylene and the butene-isobutene addition product. No combination occurs when n-butane is substituted for isobutane. The manner of carrying out the reaction is described. Tables are given that summarize the results of numerous experiments.

Behaviour of Peroxides in Benzines in Relation to Gum Formation and Storage Stability, H. SCHILDWACHTER, *Brennstoff-Chem.* **19** (1938) pp. 117-126.

The addition of small quantities of known peroxides, e.g., cyclohexene peroxide, to gasoline increased the rate of gum formation, as well as peroxide and acid on storage, or on treatment with oxygen under pressure in a bomb at 100°C. The addition of small amounts of $FeCl_3$ or $CuCl_2$ greatly accelerated gum formation on storage. Irradiation with ultra-violet light also generally accelerated gum formation. Results showing the effects of combinations of the above factors are tabulated. The gums formed had the composition: C 73.8—75.5, H 7.5—8.2, O 16.3—18.2%. The octane number



Typical flow diagram of CHEMICO Sludge Conversion Plant for the regeneration of concentrated sulphuric acid from acid sludge

CHEMICO ACID SLUDGE CONVERSION

What the process is and what it does

OPERATING PRINCIPLE AND ACCOMPLISHMENTS

A CHEMICO Sludge Conversion Plant produces clean acid, direct from the raw unseparated acid sludge. The acid produced may be 98% H_2SO_4 or of any desired higher commercial strength, regardless of the initial strength of the sludge. The output of the plant requires no further purification or concentration.

The raw sludge is decomposed by heat to strong sulphur-dioxide gas and a dry granular coke. The gas is scrubbed clean of impurities (with recovery of the oil content) and converted into sulphuric acid in a contact acid production unit employing long-lived vanadium catalyst. Operation is continuous and the equipment is sealed throughout to prevent escape of fumes. **Sludges that cannot be separated or utilized profitably by former processes are satisfactorily converted into strong clean acid.** The residue, petroleum coke, is usable as fuel and equal in worth to any other of the same calorific value. Everything is profitably utilized, and as nothing remains for disposal, every bad factor of disposal is absent.

CHEMICO Sludge Conversion plants are individually designed for the requirements of the refinery served and full responsibility is assumed by us for all material and equipment. Acceptance is asked only after the guaranteed performance is proven by impartial test.

THIS unique process offers to refiners the only satisfactory solution to the acid sludge problem.

Previous disposal of the sludge to waste meant complete loss of recoverable material, non-productive handling expense, and probable atmospheric or water pollution with accompanying grave risk of prosecution. Previous acid recovery methods on the other hand were unsatisfactory, because further processing for purification, for removal of hydrocarbons and for concentration to attain necessary strength frequently made the recovered acid cost more than it was worth.

That the CHEMICO Acid Sludge Conversion Process completely overcomes these objections is proven by the erection in 1937 of two large installations in the United States and one abroad, all ordered after thorough checking of a constantly operated first plant which was started in 1932. The new installations, to which we gladly refer, have already earned and received the high commendation of their owners.

If your acid requirement exceeds 20 tons per day, let us submit costs and operating data. Preliminary conference involves no obligation.

CHEMICAL CONSTRUCTION CORPORATION

***Main Offices:* 30 Rockefeller Plaza, New York**

***Cables:* Chemiconst, New York**

European Representatives:
Cyanamid Products, Ltd., 14 Finsbury Circus, London EC2

CHEMICO PLANTS are PROFITABLE INVESTMENTS

Keeps Discharge Constant— Full-Speed Operation Safe

As a close regulator of pressure on constant-speed pumps, the C-F Compressor Regulator has no equal. Thoroughly dependable in all applications where such a device is needed. Excess discharge pressure flows through and is relieved with no appreciable variation in the suction line. Lever-type regulator is here shown. Spring-loaded type is also available and is equally sure-working. Ask for Bulletin No. 130, also for catalog of Chaplin-Fulton Regulators.

CF

Compressor Regulator

THE CHAPLIN-FULTON MFG. CO.

28-40 Penn Avenue, Pittsburgh, Pa.

Both Mean Quality

The name "Fairbanks" on valves is like the word "Sterling" on silverware. It is a guarantee of the highest quality through and through.

Scientific design, highest grade materials, ultra-thorough workmanship and conscientious inspection are the steps by which Fairbanks won their reputation for quality valves and by which they have maintained that reputation for more than half a century.

Our large catalog No. 21 is yours for the asking.

THE FAIRBANKS COMPANY

Executive Offices: 20 East 4th St., New York, N. Y.

Boston, Pittsburgh—Distributors in Principal Cities

Factories: Binghamton, N. Y. Rome, Ga.

Fairbanks Bronze and Iron Valves

of one gasoline fell from 81 to 62 as the peroxide content increased from 0 to 1050 mg. of oxygen per liter. It was not found possible to remove the peroxides or gum by treatment with fuller's earth.

Manufacture: Processes and Plant

Heat Transfer in Viscous Liquids in Turbulent Flow, W. BUHNE, *Warme,* 61 (1938) pp. 162-5.

The laws of heat transfer established for water and gases flowing through smooth tubes to viscous liquids was studied. The coefficients of heat transfer to two petroleum oils, the viscosities of which at 20°C. were in the ratio of 1:15, were determined by passing the oil in turbulent flow through a brass tube surrounded by ice water. The data show that the coefficients of heat transfer for such viscous liquids are greater than has been previously assumed. The equations of Nusselt, Burbach, Merkel, and others, are applicable only within certain limits. Prandtl's equation can be applied subject to modifications that are discussed.

Analytical Determination of Plates in Fractionating Columns, E. H. SMOKER, *Trans. Am. Inst. Chem. Engrs.* 34 (1938) pp. 165-72.

In distillation theory the basic equations for binary solutions as derived by Lewis have become the starting point for many further studies. By assuming constant molal reflux McCabe and Thiele showed that the operating lines were straight lines. On this basis they were able to develop a graphic method for computing the number of theoretical plates required to give any desired separation of two components. This method has proved to be valuable for most cases met in practice. The method, however, has the usual disadvantage of graphic methods in that the accuracy depends upon the care given to the construction of the plots. Also it is tedious and almost impractical to apply to systems that require a large number of equilibrium units to make the separation. The author developed an analytical method that avoids these disadvantages without introducing others if too many simplifying assumptions are not made. A specific example of the application of this method is given.

Fractionation in Multiple-Draw Petroleum Columns, W. L. NELSON AND C. H. ROLAND, *Ind. & Eng. Chem.* 30 (1938) pp. 730-40.

The authors briefly review literature on the design of fractionating columns for complex mixtures and for determining the number of plates required in petroleum columns. Some of the well-known facts of petroleum distillation are also reviewed, such as the fact that the reflux in a petroleum column is not a constant quantity but varies over the entire column, and that A.S.T.M. boiling point curves are not suitable for measuring the degree of fractionation, but that true boiling point curves should be used. Equations are derived that are to be applied to studies of fractionation occurring in multiple-component fractionating columns. In a modified form these equations can be used to study fractionating systems producing several side withdrawn products. The results of calculations made by the use of the proposed equations were checked against data secured in the operation of a plant used for the separation of light gasoline and blending naphtha from crude oil by means of distillation with a small quantity of steam. A flow diagram of this plant is given. Reasonable agreement between calculated and plant results was found.

Flooding Velocities in Packed Columns, T. K. SHERWOOD, G. H. SHIPLEY, and F. A. L. HOLLOWAY, *Ind. & Eng. Chem.* 30 (1938) pp. 765-9.

In packed towers the gas and liquid rates are limited by the tendency of the column to flood. As either liquid or gas velocity is increased, the liquid holdup in the packing increases, the free area for gas flow decreases, and the pressure drop through the column increases. A point is finally reached when the gas bubbles violently through the liquid, the pressure drop rises sharply with a small increase in gas velocity, and liquid is carried mechanically by the gas leaving the top of the packing. This point is called the "flooding point." The authors present data showing the effects of gas density and liquid viscosity on the flooding velocities in an experimental packed column. Data for a number of gases and liquids obtained by using 12.7 mm. Raschig rings in the experimental column were used to develop a new method of correlating flooding velocity measurements. It was found that the surface tension of

Here's the Answer **TO YOUR TREATING PROBLEMS!**

THE HOWARD PROCESS

developed and licensed by **The Petroleum Research Corporation.**

For years Refiners have hoped for a dependable treating process which will not only desulphurize, remove gums, positively stabilize as to gums and color, without requiring inhibitor, but promote octane improvement and increase lead susceptibility . . . in one operation. There will be no argument by any Refiner that such a process—achieving these results economically—is the answer to his treating problems.

Upon cracked or straight run products, THE HOWARD PROCESS will relieve your anxieties about treating.

Secure accurate, first hand information upon this all-inclusive treating method by contacting

THE PETROLEUM RESEARCH CORPORATION

RESEARCH & TESTING LABORATORY

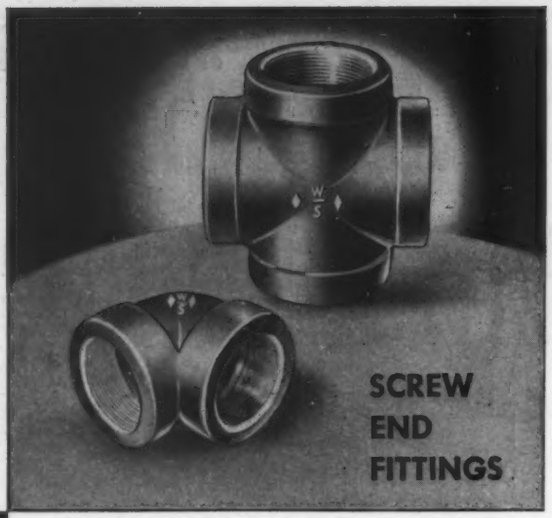
3226 Sand Springs Road **Tulsa, Oklahoma**

Executive Offices: 1364 Wrigley Bldg., Chicago, Illinois

W-S FORGED STEEL FITTINGS

for

HIGH TEMPERATURE HIGH PRESSURE SERVICE



W-S Forged Steel Fittings offer definite advantages in terms of long life and low maintenance. They are highly resistant to temperature, pressure, and corrosion and afford an extra margin of strength where it is vital and necessary. This is particularly true in respect to pipe lines carrying oil or gas.

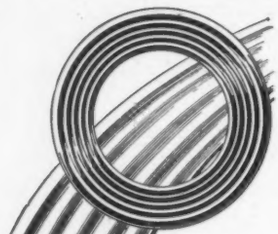
Write for Bulletin A-3 giving complete specifications. The Watson-Stillman Co., Roselle, N. J.

WATSON-STILLMAN

GASKETS THAT HOLD UP

IN THE REFINERY INDUSTRY'S USES

Having cooperated with scores of concerns in the Oil, Chemistry, Refinery and Power fields, we have the variety and extent of experience which will enable us to render good service in the solution of **your** gasket problems. Let us know your needs and we'll be glad to give you the benefit of our experience.



MELRATH

Style No. 1500

Especially adapted for use in Refineries and in Power and Chemical Plants. Asbestos core, double jacketed in corrugated metal casing. Suitable for high pressures and high temperatures, including superheated steam.

Information, drawings, samples or other assistance cheerfully provided without charge or obligation.

Send for Catalog

MELRATH SUPPLY & GASKET CO. INC.

TIOGA & MEMPHIS STS., PHILADELPHIA, PA.

Established 1909

the liquid has no appreciable effect. Making use of the new method of correlation, the data of several investigators on flooding velocities for Raschig rings varying in size from 12.7 to 35 mm. in large columns were plotted and found to be in excellent agreement. Flooding velocities when the rings are stacked are much higher than for dumped rings. The general relationship obtained for flooding velocities in dumped Raschig rings was found to be a good approximation for many other dumped packing materials.

The Absorption of Gases in Wet Cyclone Scrubbers, H. F. JOHNSTONE and R. V. KLEINSCHMIDT, *Trans. Am. Inst. Chem. Engrs.* **34** (1938) pp. 181-98.

The performance of two wet cyclone washers of the type normally used as dust washers was studied when using the devices as gas absorbers. The rate of absorption of SO_2 from dilute gases was used as a criterion. The percolated water was treated with soda ash to maintain the p_H between 5.5 and 8.0. The quantity of gas treated varied between 25,000 and 55,000 cu. ft. per minute at 500°F. The gas contained approximately 0.05% SO_2. The percentage removed in one washer receiving 100 gallons of solution per minute was better than 95%, while that of the other that received 50 gallons per minute was about 85%. The average absorption coefficients were, 4.05 and 1.58 pound moles (hr.) (cu. ft.) (atm.) respectively. The authors developed a theory of absorption for a spray droplet that agrees closely with the experimental data of Whitman and of Hatta on individual falling drops. As applied to cyclone scrubbers, the calculated value for the coefficient agrees well enough with theory to justify use of the method for general design purposes.

Utilization of Light Hydrocarbons, S. D. TURNER and A. C. RUBEY, *Chem. & Met. Engr.* **45** (1938) pp. 362-5.

The authors describe the development recently completed by the Humble Oil and Refining Company for the conservation and utilization of the lighter hydrocarbons. A supply of about 9500 barrels per day of butanes is brought to Baytown by pipeline. A portion is used to charge a thermal polymerization plant. Butanes recovered from refinery operations are passed through a sulfuric acid co-dimer plant before charging to the thermal polymerization plant. The butanes are closely fractionated, thus allowing isobutane to be used principally as the charge for the thermal plant, and n-butane to be used in gasoline blends. The fractionation plant, the thermal polymerization plant, the storage facilities, and the forced draft cooling tower, are described in some detail. A flow sheet of the fractionation plant, and one of the polymerization plant, are given.

Manufacture of Aviation Gasolines, P. MINARD, *Rev. Petrolifere* **779** (1938) pp. 401-4.

Even considering the high lead susceptibility of gasolines from certain crude oils, generally speaking an octane number of 85 is the upper limit. Higher octane ratings up to 125 can be obtained by using pure synthetic compounds as aviation fuel. Possible sources of such fuel are: isopentane, cyclopentane, isopropyl ether, acetone, isohexane, isoheptane, isooctane, toluene, xylene and ethylbenzene. A table is given that shows the octane number, initial material, process of manufacture, possibilities of production, and relative merits of each. Isooctane is the most promising material for large-scale manufacture, as it can be produced by catalytic polymerization of the C_4-fraction from cracked or reformed gasoline to produce diisobutylene. This compound can then be hydrogenated.

Solvent Extraction of Diesel Fuels, C. G. DRYER, J. A. CHENICEK, G. EGLOFF, and J. C. MORRELL, *Ind. & Eng. Chem.* **30** (1938) pp. 813-21.

The tendency toward the use of Diesel engines of lower horsepower and higher speed will require several million additional barrels of suitable fuel. A survey was made, including twenty-five manufacturers of high-speed engines, that indicated that the minimum cetane number of 45 is recommended for high-speed engines. Straight-run fuels produced from various crudes have sufficiently high cetane number to operate most high-speed engines. Cracked fuels, however, derived from crudes from various fields, have an average cetane number of 35, which is well below that recommended by the engine manufacturers. The solvent extraction of cracked Diesel fuels with sulfur dioxide and furfural produced raffinates with improved ignition quality without materially affecting other physical properties. The improvement depended upon the solvent, the percentage removed, and the method of extraction. The raffinates showed

"SUPERIOR TO ANY OTHERS WE HAVE EVER USED" *says F.C.Hall*

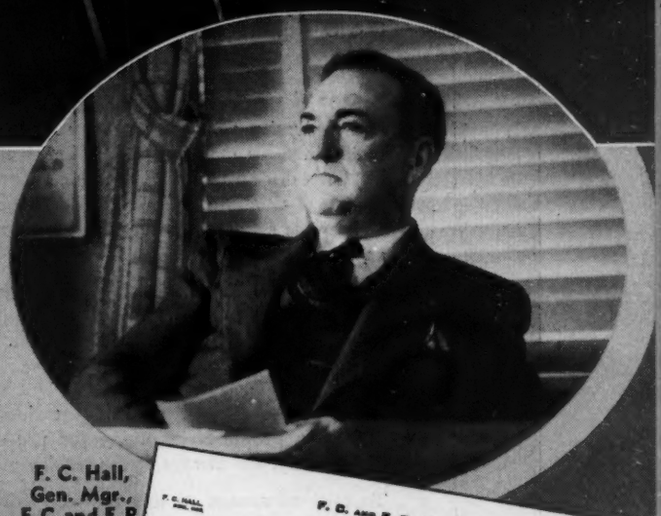
Four CLARK 400 H.P. "Super-2-Angle" Compressors, F. C. and E. P. Henderson Co. Gasoline Plant, Sanford, Texas.

F. C. Hall, General Manager of the F. C. and E. P. Henderson Company, of Amarillo, Texas, writes us, regarding the battery of CLARK "Angles" shown above, "Our records show these machines superior to any others we have ever used." These 400 H.P. "Angles" have been in service at the company's Sanford plant for the past year. Mr. Hall's letter continues:

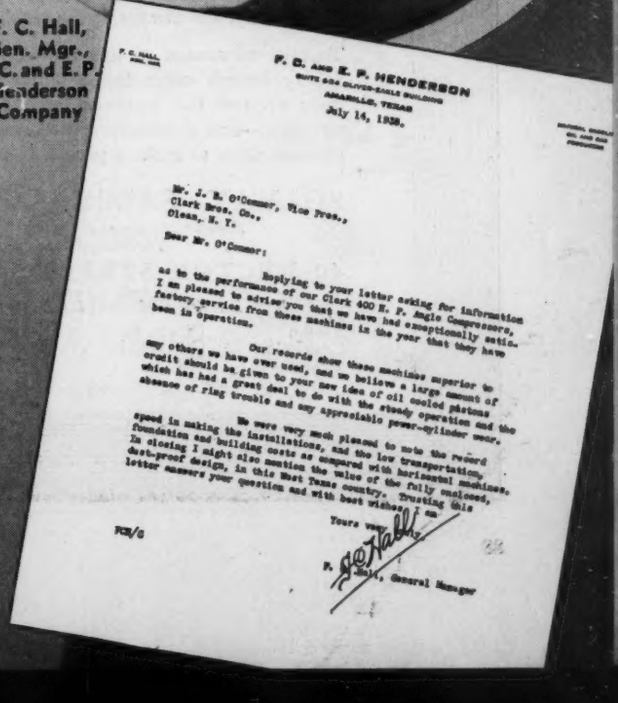
"We believe a large amount of credit should be given to your new idea of oil-cooled pistons which has had a great deal to do with the steady operation and the absence of ring trouble and any appreciable power-cylinder wear.

"We were very much pleased to note the record speed in making the installation, and the low transportation, foundation and building costs as compared with horizontal machines. In closing I might also mention the value of the fully enclosed, dust-proof design in this West Texas country."

Mr. Hall's report is typical of what hundreds of users are saying about the CLARK "Angle." Let us send you our new catalog.



F. C. Hall, Gen. Mgr., F. C. and E. P. Henderson Company



F. C. HALL
GEN. MGR.

F. C. AND E. P. HENDERSON
SUITE 506 OLIVER-EAGLE BUILDING
AMARILLO, TEXAS

July 14, 1930.

Mr. J. B. O'Connor, Vice Pres.,
Clark Bros. Co.,
Olean, N. Y.

Dear Mr. O'Connor:

Replying to your letter asking for information as to the performance of our Clark 400 H. P. Angle Compressors, I am pleased to advise you that we have had exceptionally satisfactory service from these machines in the year that they have been in operation.

Our records show these machines superior to any others we have ever used, and we believe a large amount of credit should be given to your new idea of oil cooled pistons which has had a great deal to do with the steady operation and the absence of ring trouble and any appreciable power-cylinder wear.

We were very much pleased to note the record speed in making the installations, and the low transportation, foundation and building costs as compared with horizontal machines. In closing I might also mention the value of the fully enclosed, dust-proof design, in this West Texas country. Trusting this letter answers your question and with best wishes, I am

Yours very truly,

FCH/G

F. C. Hall, General Manager

CLARK BROS. COMPANY . . . . . OLEAN, NEW YORK

Export Office: 30 Rockefeller Plaza, New York. Midcontinent Sales Offices and Warehouses: Tulsa, Okla.; Dallas and Houston, Texas. West Coast Office: Smith-Booth-Usher, 2001 Santa Fe Av., Los Angeles. Foreign Offices: 72 Turnmill St., E. C. 1. London, England; 4 Str. General Poetas, Bucharest, Roumania.

CLARK

unchanged susceptibility to a pour-point depressant. The extracted portions had high-octane blending values and low pour points. Extraction of straight-run fuels caused less improvement in ignition quality than the solvent treatment of cracked fuels. Acid treatment resulted in a negligible increase in ignition quality. Hydrogenation of fuels of low sulfur content produced fuels of high ignition quality. The extensive data are presented in tabular form, and a bibliography of 23 references is given.

Characteristics of Base Metal Thermocouples, M. R. MANDLEKAR and H. N. BANERJEA, *Current Sci.* **6** (1938) pp. 447-8.

The thermoelectromotive force relationships of some of the common base metal thermocouples and the characteristics of these metals were studied. The Nichrome-Constantan couple has been found reliable at moderate temperatures (to 800°C.). The couple gives an almost straight-line thermoelectromotive force relationship and as wide an e. m. f. as is obtainable with Iron-Constantan and Copper-Constantan couples. Thermocouples containing nickel (as in combination with Nichrome, iron, or copper) generally give irregular thermoelectromotive force curves over the temperature range 250-400°C. This is apparently caused by some molecular transformation taking place in the nickel. This effect is overcome when Constantan is coupled with the nickel.

Drum Construction Is Improved, Specifications for the New ICC-5E Drum, *Chem. & Met. Engr.* **45** (1938) pp. 366-9.

The Steel Barrels and Drums Committee of the Manufacturing Chemists' Association has been successful in obtaining the approval of the Interstate Commerce Committee and the Consolidated Classification Committee of changes in the specifications for the 18 gage, 55 gallon and the 19 gage, 30 gallon steel drums. The new light-weight drum means a potential saving of over a million and a half dollars annually to chemical manufacturers. The tests used by the committee to demonstrate its contention with respect to changes in drum specifications are described.

SOLVAY

TRADE MARK REG. U. S. PAT. OFF.

Service

...AT YOUR SERVICE

For 57 years Solvay has marketed many kinds of alkali and derivative products to many kinds of industries. To maintain these markets, and to build new ones as Solvay has done during this half-century of constantly accelerating industrial developments, it has been necessary not merely to be wide awake to progressive changes . . . but to take an active part in producing them.

Part of Solvay's job is to know its customers' problems . . . to study them . . . to be equipped to contribute concretely toward an efficient solution.

The oil industry is a case in point.

Solvay technologists, especially trained to give expert advice on problems involving the use of Alkalies in the oil industry, are always at the service of refiners.

To take advantage of this service, write to your nearest Solvay branch office listed under the Solvay signature. Your request for technical advice will receive prompt attention—and if necessary, a technical expert will be sent to your plant to make a personal study of your problems.

SOLVAY SALES CORPORATION

Alkalies and Chemical Products Manufactured by The Solvay Process Company

40 RECTOR STREET NEW YORK

BRANCH SALES OFFICES:

Boston	Cincinnati	New Orleans	Pittsburgh
Charlotte	Cleveland	New York	St. Louis
Chicago	Detroit	Philadelphia	Syracuse

Products: Properties and Utilization

Some Investigations on the Constitution of Mineral Lubricating Oils, E. H. KADMER, *Oel u. Kohle* **14** (1938) pp. 1-6.

Because it is practically impossible to separate lubricating oils into their component hydrocarbons by fractionation, solvent extraction or other means, other methods must be used to gain knowledge of their composition. All lubricating oils contain paraffins, naphthenes, and aromatics, and some idea of the relative importance can be obtained from the properties of the oil. Some of the physical properties of the oil are related to each other. These include: (1) density, (2) Ubbelohde's "viscosity pole height" Vph, (3) Ubbelohde's "Viscosity slope," m, (4) Dean and Davis' viscosity index, Vi, (5) aniline point, AP, (6) mean molecular weight mM.G., (7) refractive index nD/20, (8) dispersion. The density of 140 refined lubricants have been plotted against their Vph, and on the same graph viscosities E. 50 against Vph. Although the points scattered somewhat it was nevertheless seen that low values of density were associated with low values of Vph. An even better relationship was found to exist between density, E.50 and m. Other graphs are plotted showing the relationships between (a) AP, d_{20}, and E.50, and (b) m.M.G., d_{20} and E.50. The authors discuss the formula put forward by Fenske, McCleur, and Cannon for calculating the mean molecular weight from a knowledge of the viscosity and viscosity index. They show that this formula has only limited application. This also appears to be true of other empirical formulae suggested to correlate certain properties.

Static Electricity in Dry-Cleaning Processes, L. HARTSHORN and W. H. WARD, *Jour. Soc. Chem. Ind.* **57** (1938) pp. 178-83.

Static charges are often generated by friction in the dry-cleaning of fabrics, and sparks produced in this manner have been known to lead to serious explosions. Special soaps have long been used in the dry-cleaning industry, partly for their cleaning properties, and partly because they were considered to prevent the generation of static electricity. Those experiments made with various typical soaps have shown that from the electrical point of view their active component is water, and soaps containing no water have little effect on the generation of static charges. The function of the soap is to carry the water into solution, thereby greatly increasing the electrical conductivity of the cleaning liquid. Fabrics of silk, cotton, or wool remove the water from solution, so that if many successive charges of fabric are added to the same liquid, the conductivity steadily falls and the tendency to geneate static charges increases. In the interests of safety it is therefore desirable to add fresh soap solution periodically. The amount added should be sufficient to raise the electrical conductivity of the liquid to a value of the order of 10^{-11} mho/cm. A simple method of measuring conductivities of this order is described.

Sulfuric Acid Analysis of Gaseous Olefins, MARYAN P. MATUSZAK, *Ind. & Eng. Chem. Anal. Ed.***10** (1938) pp. 354-60.

The principles and limitations governing the selection of conditions for determination of the gaseous olefins by absorption in sulfuric acid are briefly presented. Data are given showing the influence of the following previously uninvestigated factors: (1) reversibility of absorption; (2) solubility of gaseous paraffins in sulfuric acid; (3) increase in solubility of hydrocarbons because of acid-soluble absorption products; (4) solubility of hydrocarbons in precipitated polymer products; and (5) liberation of unabsorbable gas by overstrong absorbents, inculding those containing silver sulfate. Suitable apparatus and proper technic for overcoming the effects of these factors are described. Within its natural limits of applicability, the improved method gives, for samples of all possible olefin concentration, rapid and reliable results.

THE Power Piping Division of Blaw-Knox Company, Pittsburgh, manufacturers and erectors of prefabricated piping for power plants, oil refineries, and other industrial usages, has opened a southern sales office in the Candler Building, Atlanta, Georgia. O'Earl Kearney, who has had extensive experience in the power plant and industrial piping fields during the past 20 years, is in charge.

How

A MEETING IN 1914 helps you get your money's worth in advertising space TODAY

IF you bought advertising space thirty years ago, you will remember how hard it was . . . how frequently impossible—to get information on circulation needed for effective space buying.

In 1914 a group of clear-headed men, tired of deploring the situation, resolved to do something about it. Their meeting resulted in the formation of one of the most remarkable examples of an industry's self-control—the Audit Bureau of Circulations.

Today, A.B.C. reports reveal and analyze NET PAID CIRCULATION—the true measure of advertising value.

A.B.C. reports answer the three vital circulation questions: how much is there? where is it? how was it secured? A.B.C. reports give verified information on the *quantity,* and an important index of the *quality* of circulation.

Before you buy space in any publication, study the A.B.C. report carefully. Know what you're getting. Then buy—and get what you pay for.

• • •

Ask for a copy of our latest A.B.C. report. It will give you quickly and completely the facts you want to know about the circulation of this paper.

REFINER and Natural Gasoline Manufacturer

HOUSTON, TEXAS

An A. B. C. Publication

A.B.C. = Audit Bureau of Circulations = FACTS as a yardstick of advertising value

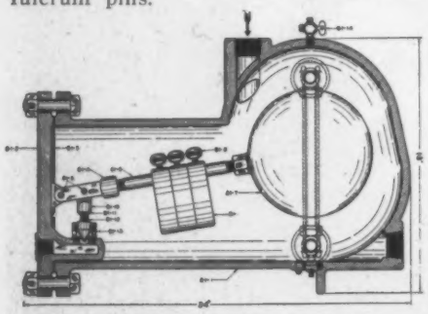
New Equipment for the Modern Plant

Drainer

HANLON-WATERS, INC.

Hanlon-Waters, Inc., Tulsa, announces development of the new Hanlon-Waters Type 91 duo-gravity drainer. The drainer is to be used for continuously drawing condensate from vessels containing oils or distillates, and for use on water knock-out trays of gasoline plant stills, reflux accumulators and gasoline run tanks.

The bodies are available in either semi-steel for 150-pound working pressure, or electric cast steel for 500-pound working pressure. The valve plug and renewable seat are of 18-8 stainless steel, as well as the ball float and fulcrum pins.



Hanlon-Waters Duo-Gravity Drainer.

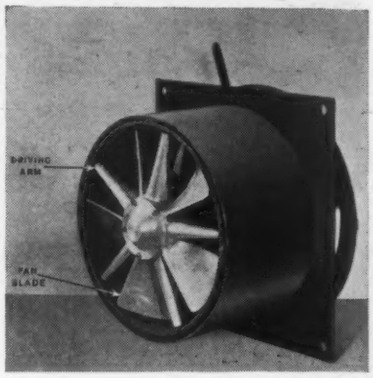
It is claimed that the complete absence of stuffing boxes reduces operating friction and maintenance to a minimum. The friction-free action insures tight closure when no water is being formed to prevent the loss of gasoline or oil. The float rod is counter-weighted so that the float will sink in the oil and float on the water and ride on the interface. The absence of outside levers, counterweights, and adjustments prevents tampering by unauthorized persons, it is said. All internal working parts are readily accessible by removing the head flange without disturbing the equalizing piping connections. The valve plug and seat are easily renewable, or they can be replaced with larger or smaller sizes as desired. The over-all construction is rugged and fool-proof. Complete capacity and calculation charts are available from the manufacturer.

Gas Burner

COPPUS ENGINEERING CORPORATION

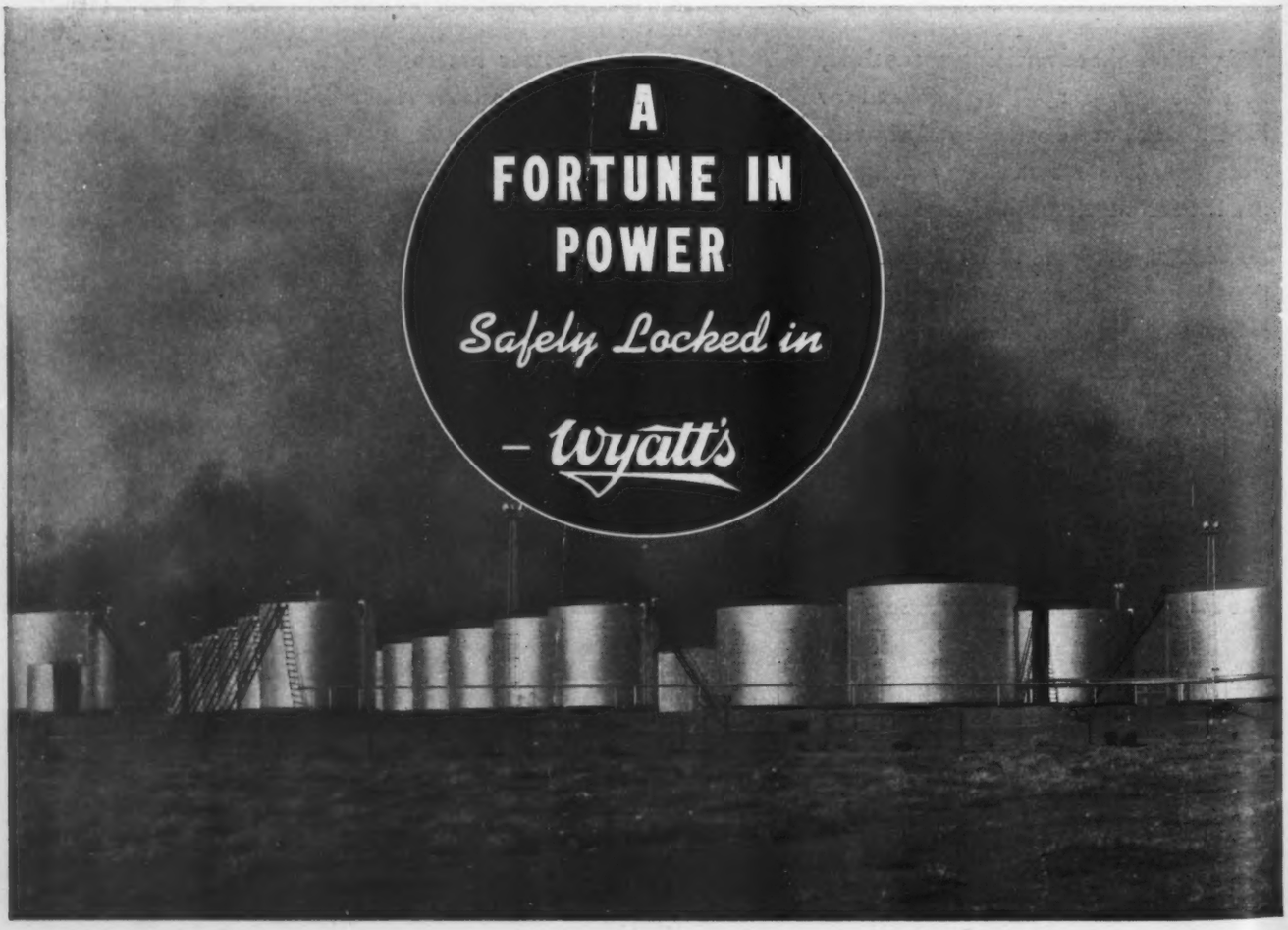
Coppus Engineering Corporation, Worcester, Mass., is introducing a new line of gas burners, representing a change in gas burner design.

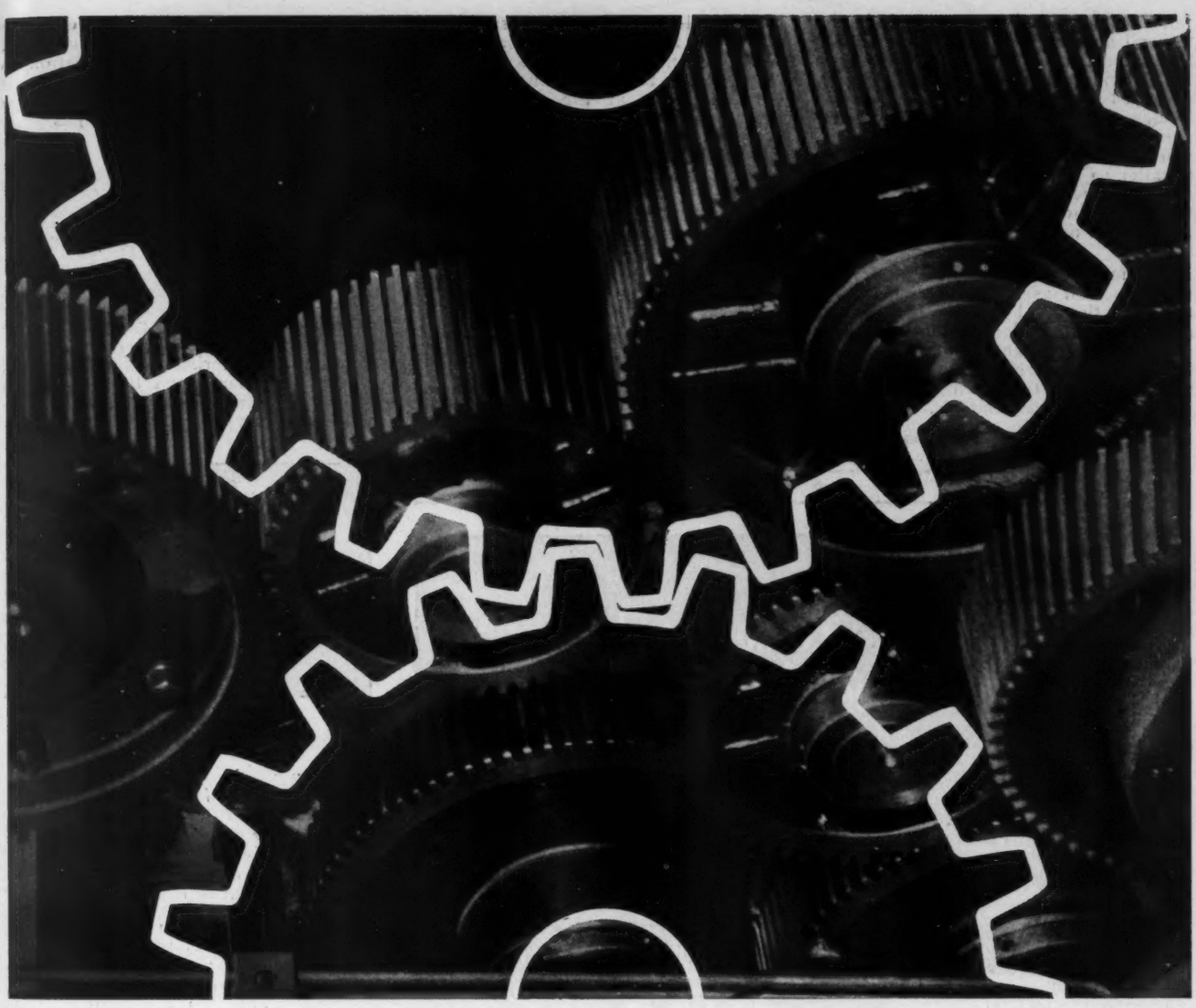
Whereas heretofore all gas burners could be classified in three groups, the venturi type, the ring type and the center fired diffusion type, the Coppus-Dennis FANMIX gas burner uses a different principle of mixing gas and air, the manufacturers state.



Coppus-Dennis Gas Burner

It is a rotary gas burner consisting primarily of a fan with a long hub in which two ball bearings are mounted, so that the fan rotates on a stationary shaft which serves at the same time as gas-inlet pipe. The gas is admitted through the hollow shaft and enters the





PRECISION GEARS AT LOW COST

THE quality of the gears in a high-grade machine tool determines its performance.

One well-known machine-tool builder finds 0.35% Moly Chrome-Molybdenum iron meeting all requirements for main and intermediate gears in an automatic crankshaft lathe. The iron is wear-resistant enough to assure maintenance of original tooth profiles, thus eliminating tool chatter. Its structure—and therefore its strength—is uniform. There is no trouble from porosity at the bases of the gear teeth. This Chrome-Moly iron also holds down production costs. It is comparatively inexpensive. It machines easily. And in the case referred to above there has never been any waste from defective castings since it has been adopted.

If resistance to wear, uniform strength, plus economical production are vital requisites in the gears, pulleys or similar machine parts you make or use, investigate Moly irons. Our book, ***"Molybdenum in Cast Iron,"*** is free to engineers and production executives. Climax Molybdenum Company, 500 Fifth Avenue, New York City.

PRODUCERS OF FERRO-MOLYBDENUM, CALCIUM MOLYBDATE AND MOLYBDENUM TRIOXIDE

Climax Mo-lyb-den-um Company

MOLY

fan hub. The fan has several air blades as well as driving arms. The gas flows into these arms, leaves them through small orifices and, by reaction, causes the fan to rotate at high speed. The fan blades then act as any other power-driven fan, delivering air for combustion. As the air flows in a direction parallel to the shaft and the gas flow is in a plane practically at right angles to the air flow, a very thorough mixture of gas and air is obtainable directly at the fan.

The number of orifices in the driving arms as well as the gas pressure determines the total amount of gas flow and its reaction force determines the speed of the fan and hence the air delivery. The fan can be therefore designed so that there will be a perfect ratio between gas and air. If a lower rating is desired, the gas pressure is reduced, decreasing the total amount of gas flow and also causing the fan to slow down, thereby reducing the air volume. Thus, at the lower ratings, again a practically perfect ratio between air volume and gas volume is obtained; any final adjustments of the air volume can be made with the inlet shutter.

The Coppus-Dennis "Fanmix" gas burner discharges a perfect combustible mixture into the combustion chamber and as a result of the instant ignition a smaller combustion space is required. Absolutely no flame is visible, making the burner a truly radiant heat burner, it is claimed.

Other advantages claimed are: High efficiency, high and even furnace temperatures, no "hot spots," low up-keep, 100 percent turn-down ratio, reduction of stack requirements, no cracking of "wet" gas and low cost installation as high pressure valves and fittings can be used. The burner is primarily a high pressure burner, operating at gas pressures of 5 to 40 pounds.

Lighting Unit

BENJAMIN ELECTRIC MANUFACTURING COMPANY

Benjamin Electric Manufacturing Company, Des Plaines, Illinois, announces a new lighting reflector specifically designed to utilize the indirect lighting characteristics of the silvered bowl Mazda lamp and thus provide a greater degree of eye comfort at relatively low cost.

Benjamin Reflector

Known as the Benjamin RLM "Silvered Bowl" Diffuser, the new unit makes more effective use of the silvered bowl lamp by an innovation in diffuser design. Through the proper combination of porcelain enamel and Alzak aluminum reflecting surfaces and the use of the silvered bowl lamp, a softer, better diffused illumination is secured without sacrificing high lighting efficiency, it is claimed. The Alzak aluminum reflector is located in the top of the unit and redirects the light from the silvered bowl lamp downward and outward in a manner which avoids interception of the light rays by the lower edge of the porcelain enamel reflector. In this new Benjamin unit, the silvered bowl lamp produces a broader candlepower distribution with the minimum of direct or indirect glare, it is claimed.

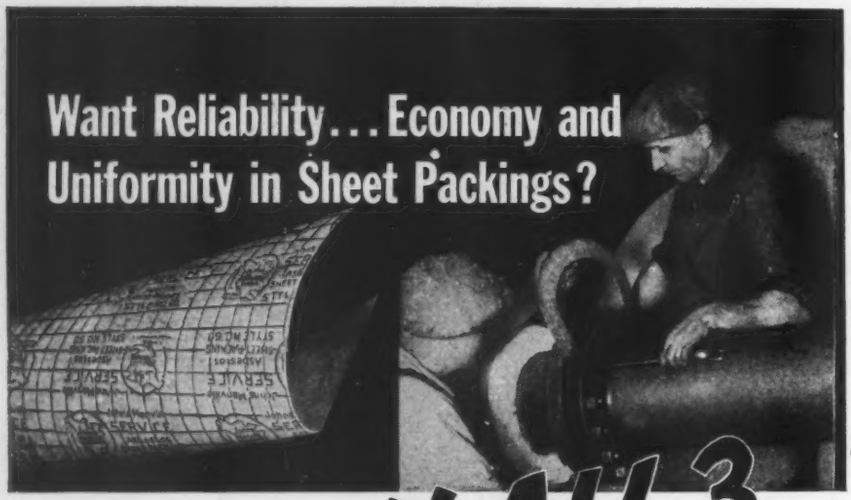
The new unit meets all specifications of the RLM Standards Institute and bears the RLM label of compliance. The units are available in socket reflector and turnlox type of hood construction.

Welding Cleaner

THE LINCOLN ELECTRIC COMPANY

Lincoln Electric Company, Cleveland, Ohio, announces a new compound, which is said to reduce cleaning time after welding by 20 to 60 percent.

This new compound, known as "Spatter Film," has been developed by Lincoln engineers to increase the economy of electric welding as a process of manufacture and fabrication. By reducing the tendency of spatter to adhere tightly, thus facilitating its removal. "Spatter Film" makes fabrication by arc welding still more economical. The savings resulting from use of the compound will be particularly



You get ALL 3

in J-M SERVICE SHEET (Style No. 60)

SHEET PACKING worthy of its name must offer dependability and economy in use on a wide variety of service conditions. And there must be no variation in quality from one shipment to the next.

To this rigid standard J-M Service Sheet (Style No. 60) is designed and manufactured. Over sixty years of experience go into its making . . . into its carefully guarded uniformity.

Made of selected long-fiber asbestos and special heat-resisting compounds, J-M Service Sheet has a record for outstanding performance on flanges and other parallel surfaces against superheated or saturated steam . . . against gas, oil, air, water, ammonia, certain acids and alkalies.

• • •

Have you a copy of our latest packings catalog on hand for quick reference? It describes the complete line of J-M Materials—designed to meet every specific packing need in your plant. Simply write Johns-Manville, 22 East 40th Street, New York City.

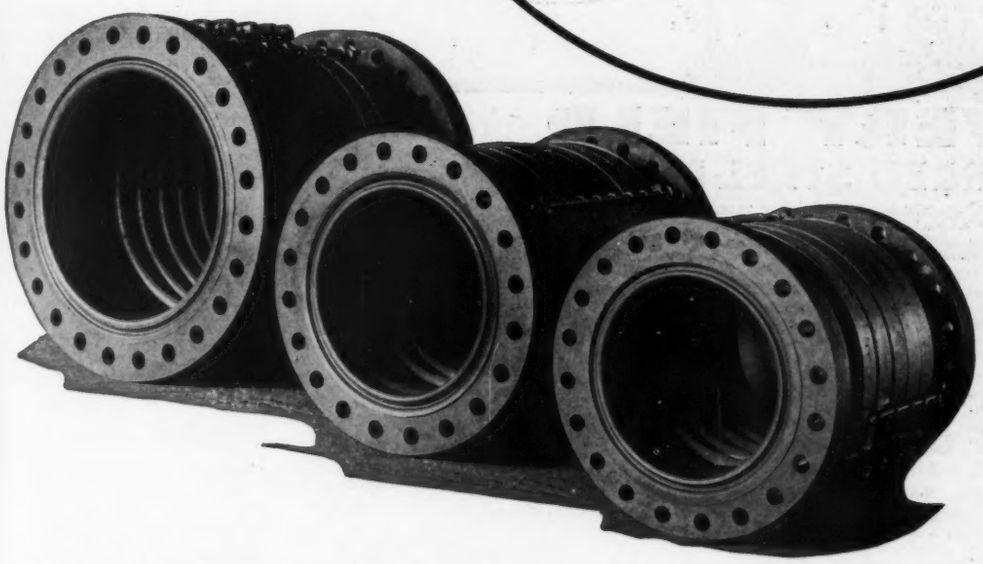
JM Johns-Manville PACKINGS AND GASKETS

BADGER EXPANSION JOINTS

Save Space

Eliminate JOINT MAINTENANCE

Solve 2 *Problems with* 1 JOINT



The Badger Corrugated type of Expansion Joint provides a compact, maintenance-free method of taking care of pipe expansion and contraction. It takes up no more space than any pipe fitting. It saves in insulation. It requires no packing—hence no servicing.

The line of Badger Expansion Joints is very broad, taking care of lineal movements ranging from only a small fraction of an inch up to 6 inches.

Copper or stainless steel expansion joints are available, the latter for high pressures, temperatures, and corrosion. The exclusive Directed Flexing feature, coupled with controlled heat treatment, assures long life. Bulletins 100 and 200 give full details.

E. B. BADGER & SONS CO.

75 Pitts Street, Boston, Mass.

AGENTS IN PRINCIPAL CITIES

apparent in work where painting and finishing are essential.

"Spatter Film" is soluble in water. It is non-inflammable and contains no free alkali to injure the hands nor harm paint. It is easy to apply by means of an ordinary paint brush. Only sufficient of the film need be applied to cover the work adjacent to the seam or joint. A gallon will cover approximately 50,000 square inches of surface. It can be removed readily for painting by wiping with a clean cloth, if still wet, or by washing it off with water if dry.

Savings in cleaning time, through use of "Spatter Film," ranged between 20 and 60 percent on various applications of the compound. Time to clean welded work, consisting of a 10-inch single bead fillet weld joining two pieces of 12-gauge plate with 5/32-inch electrode was .84 minute using the compound, as compared with 1.04 minutes without it. For a 9-inch single bead, joining ¼-inch flat steel plates with 3/16-inch electrode, cleaning time with "Spatter Film" was .58 minute; without, 1.54. Ordinary cleaning tools, consisting of wire brush, flat sharp chisel or old file sharpened as chisel, were employed.

"Spatter Film" is sold in quart, gallon and 5-gallon cans, or 55-gallon drums. The weight is 8¾ pounds per gallon.

Hose Masks

ACME PROTECTION EQUIPMENT COMPANY

The Acme Protection Equipment Company, 3601 Liberty Avenue, Pittsburgh, is now introducing a supplemental line of hose masks (fresh air type) which have just been approved by the United States Bureau of Mines. These new masks are designated as Acme Full Vision Supplied-Air Respirators and bear Bureau of Mines Approval No. 1910.

Acme Hose Mask

At the same time, the manufacturer announces that Bureau of Mines approvals have been granted for Acme Full Vision Gas Masks Nos. 4 and 4A when equipped with Type 1-OV canisters.

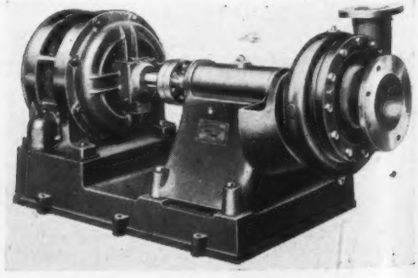
Acme Supplied-Air Respirators are used by workmen who must enter high concentrations of poisonous gas or oxygen-deficient places such as oil tanks, tank cars, vats, underground passageways, sewers, around blast furnaces, etc. A blower, mounted in a substantial, fibre trunk, which is placed outside the danger zone, is used to furnish the wearer of the mask with cool, fresh air. Full Vision lenses permit wearer to work safely and effectively and to see as well as when not wearing a mask.

Centrifugal Pump

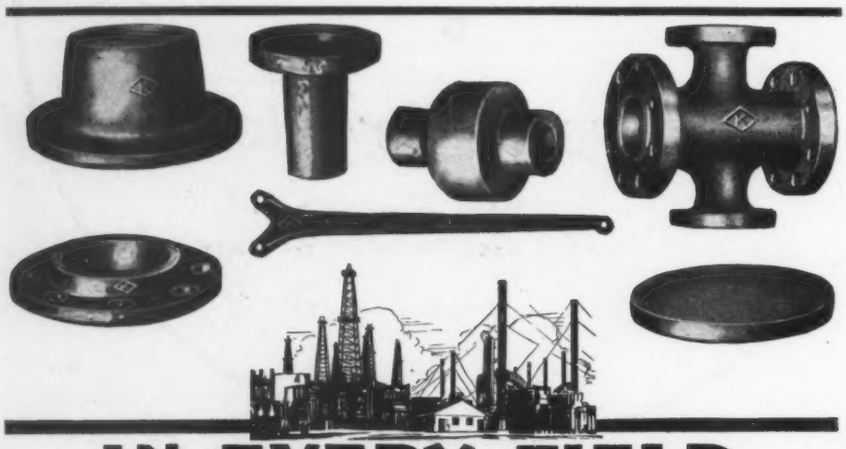
LAWRENCE PUMP & ENGINE COMPANY

Lawrence Pump & Engine Company, Lawrence, Mass., recently announced the new type "HBD" single stage side suction Vortex centrifugal pump. The unit is said to be an especially rugged and heavy duty design for general industrial pumping. Sizes range from 1½ to 18-inch discharge; capacities from 10 to 15,000 gallons per minute and heads up to 300 feet in the smaller sizes.

The pump casing is solid volute type with removable suction head. The eccentric nozzle on the suction head permits removal without disturbing the



Lawrence Centrifugal Pump.



IN EVERY FIELD

KROPP FORGED STEEL FLANGES

Years ago word got around among oil and refinery men that Kropp could make quick delivery from stock of forged steel flanges of all kinds and sizes—companion flanges, welding necks, and casing heads—and today Kropp serves every field. We're never caught short. We stock over 500,000 flanges ready to ship on receipt of order to Tulsa, Tiflis or Tampico!

Kropp makes forgings to specifications, too, for the petroleum industry: die or hammer forgings, in any quantity, heat-treated, rough finished or machined; any size; any specification of steel. Our knowledge of operating conditions in the field and long contact with the industry enable us to serve you intelligently and with speed that will surprise you.

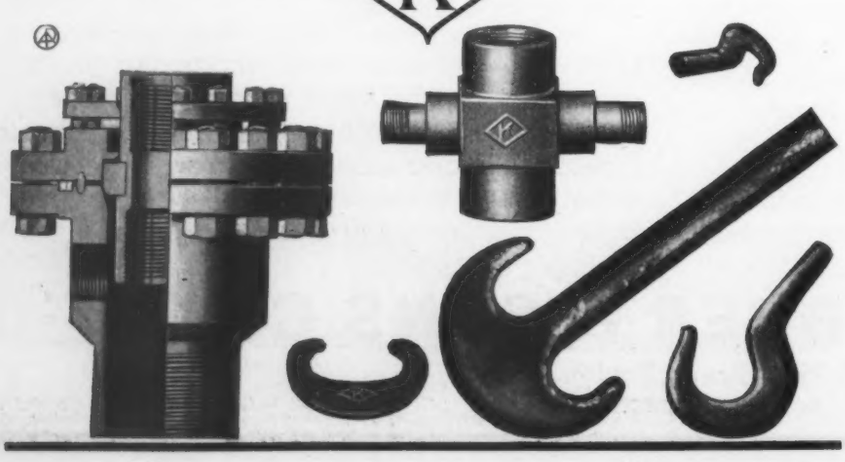
Send us your blueprints for a quotation. Request a copy of "Forgings to Your Specifications" outlining our facilities for serving you, and showing representative Kropp oil field forgings.

KROPP FORGE COMPANY

5313 West Roosevelt Road — Chicago, Illinois

Sales offices in Tulsa, Dallas, Houston, Pittsburgh, Los Angeles and New York

Representatives at Birmingham, Cincinnati, Cleveland, Denver, Detroit, Indianapolis, Milwaukee, St. Louis, St. Paul, Buffalo and Seattle



PIPEWRENCH PETE SAYS:

LET THE TIGHT-ROPE WALKERS WORRY

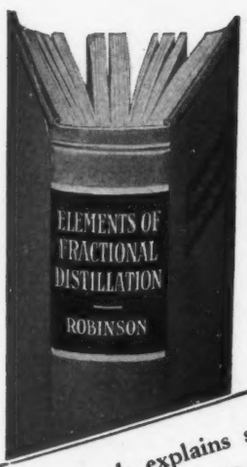
"Used to be a worry wart, I did, on how to get inverted traps to work. Buckets balanced, traps would spit and dribble. Then I discovered Strong Traps with their patented anti-balancing device. Further down the bucket goes, the wider the vent. Let the tight-rope walkers worry about balance from now on. I'm sticking to fast-action, anti-balance Strong Inverted Traps."

Write for Bulletin 63-R5 on Strong Steam Traps

STRONG

STEAM TRAPS

The Strong, Carlisle & Hammond Company
1392 West Third Street, Cleveland, Ohio



Elements of Fractional Distillation

By
Clark Shove Robinson
Assistant Professor of Chemical Engineering, Massachusetts' Institute of Technology

$3.00

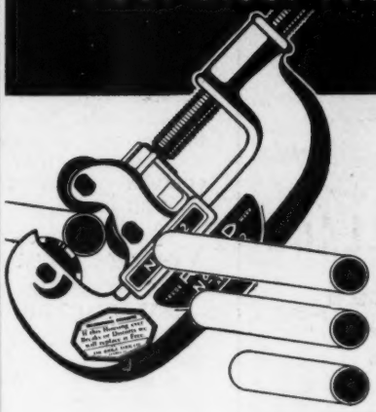
This book explains simply and accurately, according to the best ideas of physical chemistry and chemical engineering, the principles of fractional distillation, illustrating these principles with carefully selected applications.

204 pages
5½ x 8, illustrated.

INTERNATIONAL CHEMICAL SERIES

GULF PUBLISHING COMPANY
P. O. Box 1307
HOUSTON, TEXAS

This Unusual RIDGID Alloy Tool-Steel Wheel-Blade



Gives You Faster Lower Cost Pipe Cutting

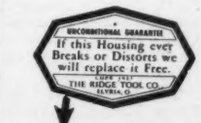
Your skill at mechanics makes it easy for you to see why this RIDGID Cutter with its new style wheel-blade can cut pipe more quickly and cleanly and last far longer, giving you extra economy.

For the RIDGID knife-like blade is coined out of fine tool steel, hammered, heat-treated and then assembled in the hub. That's what gives it the unusual stamina for hundreds of extra cuts, reducing cutter wheel expense, as thousands of users know.

Powerful housing, guaranteed warp-proof, always cuts true, twirls easily to your pipe size. You like the "feel" of this tool, enjoy working with it.

For time and expense saving and a tool you get a "kick" out of owning and using, buy the RIDGID Cutter — at your Supply House.

THE RIDGE TOOL CO., ELYRIA, OHIO



Stop 75% of your pipe wrench repairs with this famous RIDGID

That guarantee is your assurance that you won't have any expense for wrench housing repairs — nor the annoyance of wrenches out of commission. Buy from your Supply House.

RIDGID PIPE TOOLS

CALL US

for the following

TAYLOR FORGE PRODUCTS

Flanges, Weldells, Welding Reducers, Welding Tees, Flanged Unions, Special Flanges, Orifice Flange Unions, Boiler Nozzles, Welding Neck Nozzles, Spiral Welded and Spiral Riveted Pipe.

PRINCIPAL ITEMS STOCKED IN HOUSTON

THE CORBETT-WALLACE CORPORATION

2418 Winter Street
HOUSTON, TEXAS

Distributors for

TAYLOR FORGE & PIPE WORKS

HOUSTON PHONE: C-5327; L. D. 363

discharge pipe of pump alignment and also eliminates air pockets. The impeller is the enclosed type, cast in one piece, balanced and locked on the shaft by a long key and non-rust impeller nut. The supporting bracket and pump casing are separate parts with machined male-female fit between to insure perfect alignment. Close grained cast iron is standard for the casing. The fact that the pump casing and bracket are separate parts permits casing to be furnished inexpensively in special alloys for handling corrosive liquids. The impeller is furnished in cast iron, bronze, or special alloy when specified. Two heavy duty double row ball bearings, lubricated by an oil reservoir, and entirely free from the pump, support the shaft. The bearing nearest the pump carries the radial load and is self-aligning. The outer bearing of angular contact type carries the thrust and radial loads. The packing gland is of bronze and is a split, two-piece interlocking type that may be easily and completely removed when packing the stuffing box.

Voltage Transformers

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., announces the Westinghouse PV-130 portable voltage transformers which are designed for use with portable instruments and recorders. They may be advantageously used on all portable and laboratory applications in delta connection except for standards.

An accuracy of within ± ¼ percent on ratio and 20 minutes on phase angle is provided under ordinary conditions of load and power factor. When used with special test data the ratio may be corrected to within 0.1 percent and the phase angle to within 3 minutes.

Designed for 115 volts secondary these transformers are available in two sizes. The small size for primary voltages up to 2300 volts weighs 24 pounds and measures 5¾ x 7-1/16 x 7¼-inch. The large size for primary voltages from 2300 to 6900 volts weighs 48 pounds and measures 7¾ x 9-3/16 x 9⅛-inch.

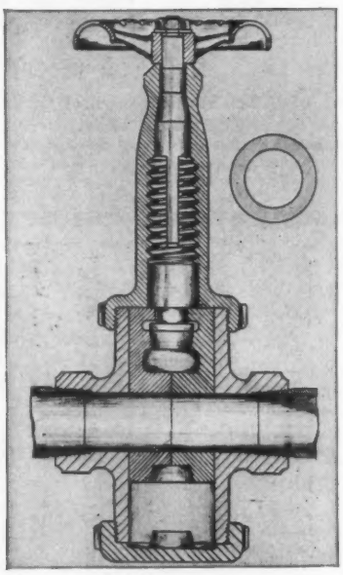
Shell type construction is used. The terminals are mounted on clearly marked moldarta terminal block which forms the top panel on the transformer. Primary and secondary terminals are made of bare polished nickel thus avoiding any assumption concerning insulation of these terminals.

Packless Gate Valve

MONAT VALVE & FORGE COMPANY

Monat Valve & Forge Company, 1005 Bessemer Building, Pittsburgh, has recently developed a packless, cylindrical gate valve, suitable for high as well as low pressures and temperatures.

This new, rugged valve, designated as the Monat "Stream-Flow," contains the



Monat Gate Valve

salient construction features of both gate and plug valves. There are no cavities and friction is eliminated. It is available in sizes ranging from ½ to 8 inches in the standard metals, and in special metals and alloys for lines handling corrosive liquids and gases.

The body of this new valve carries a cylindrical bore, at right angles to the line of flow. A cylindrical gate is moved up and down by means of a screw in the valve bonnet, and is prevented from turning by a key in the cylindrical bore. The run of the valve conforms in shape and size to that of the pipe—namely, that it is circular.

No packing is required. The only operating part in the line of flow is the gate itself. A cap on the bottom of the body and the removable bonnet permit cleaning the valve while it is in the line. Monat valves are used for steam, oil, gasoline, varnish, food products, gases, air, etc.

CORROSION plays no favorites. It never fails to find the weak link in the chain; the weak spot in the pipe line. When you weld with WeldELLS you eliminate *all* weak spots — those which would be attacked by corrosion as well as those which might yield to mechanical stresses due to expansion.

This expansion loop in an overhead vapor line is an example of this. The 20-inch WeldELLS are ¾" thick to allow for corrosion. Welded as only these engineered fittings can be welded, every part of this line is ready to do 100% battle against stress and corrosion.

With six features that are combined in no other welding fitting, WeldELLS are the final answer to a long existing need — the need for uniformly strong lines with joints that never leak — with joints as strong as the pipe — with smooth interiors that cut flow resistance — with smooth, sightly, easily insulated exteriors.

The line of WeldELLS and other Taylor Forge Fittings contains the largest range of sizes, types, and thicknesses. Large stocks are carried by distributors serving every branch of the oil industry.

TAYLOR FORGE & PIPE WORKS

General Offices and Works: P. O. Box 485, Chicago New York Office: 50 Church Street

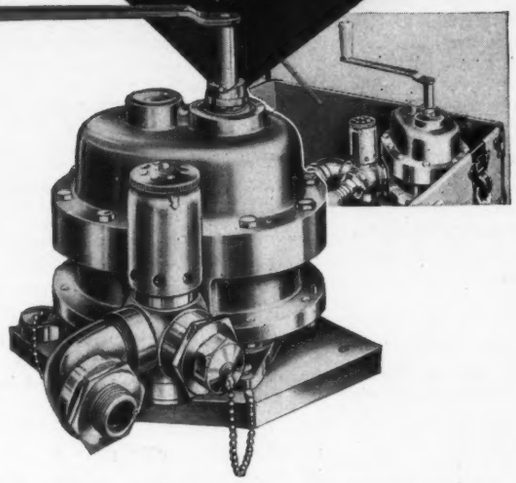
TAYLOR FORGE **WeldELLS*** Seamless Pipe Fittings for Welding

*Trade Mark Registered

Now... YOU CAN HAVE M-S-A HOSE MASKS WITH THE NEW

M-S-A DISPLACEMENT BLOWER

Approved by the U. S. Bureau of Mines
(Under Approval No. 1905-A)



- Furnishes maximum air delivery with least effort.
- Latest-type sealed ball bearings throughout, permanently lubricated. No grease or oil-packed gear chamber to fill.
- Vertical mounting for greatest comfort in cranking. (Can be furnished with horizontal mounting if desired.
- Specially-designed calibrated pressure release valve sounds audible signal when excess air is delivered. Valve can be regulated to lengths of hose used, so that correct amount of air is supplied at all times with minimum revolutions per minute.
- Fresh air by-pass valve functions automatically and allows wearer to breathe easily through the hose in event of blower stoppage.
- Definite displacement principle is employed—no metal-to-metal contact—requires no internal lubrication.

The latest refinement for M. S. A. Hose Masks is well worth your immediate investigation. The M. S. A. Displacement Blower brings *new safety, new efficiency to the job* . . . . supplying air metered to the worker's requirements, under definite control . . . . with nearly effortless ease of operation. Write for the details—or better, ask for a demonstration!

MINE SAFETY APPLIANCES CO.

Braddock, Thomas & Meade Sts., Pittsburgh, Pa. District Representatives in Principal Cities

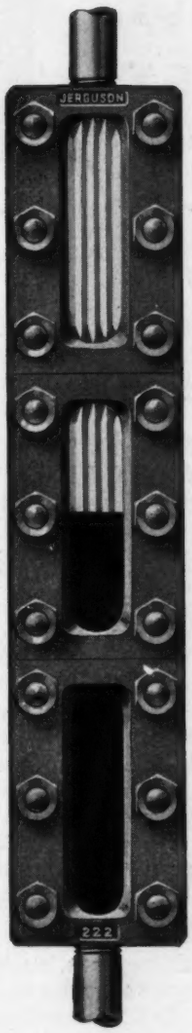
M. S. A. Products include Breathing Apparatus . . . Inhalators . . . Comfo Respirators . . . Masks of all Types . . . Gas Indicators . . . Gas Detectors . . . Safety Goggles . . . Protective Hats and Caps . . . Edison Electric Cap Lamps . . . Safety Clothing . . . First Aid Equipment . . . Descriptive Bulletins on request.

JERGUSON

REFLEX GAGES

Year in, year out Jerguson has served the industry, supplying these accurate, dependable gages for steam boilers and for indicating liquid levels in tanks, towers, stills, etc. Every oil man knows—

The *empty* space appears WHITE



The *liquid* shows BLACK

Safe and dependable at all temperatures and pressures. Furnished with or without valves for every type of service. Full information upon request.

JERGUSON GAGE & VALVE CO.

87 FELLSWAY

SOMERVILLE, MASS.

HERE OAKITE CLEANING SALVAGES

4,000 Bolts and Nuts a day at surprisingly LOW COST

How to lower costs of removing heavy deposits of paint, oil and rust from thousands of nuts and bolts? That was the problem faced by one large storage tank manufacturer whenever one of his rented tanks was dismantled and returned for reconditioning.

Recently, a different and NEW method of doing this job was tried. Bolts and nuts were first soaked in a hot solution made up with a material recommended by the local Oakite Service Representative. The thick coatings of paint and oil were quickly and easily softened so that a water rinse removed them. Following this, bolts and nuts were immersed for short period in Oakite Compound No. 32, to remove rust accumulations. Results were highly gratifying. At the final rinse, every trace of paint, oil and rust had disappeared. Bolts and nuts were clean, threads unharmed, practically as good as new.

On jobs like this and others, such as cleaning oil coolers, stripping paint from tanks, steam cleaning, etc., let efficient Oakite methods and materials bring you wanted economies. Tell us your problem . . . we can help you.

Manufactured only by
OAKITE PRODUCTS, INC.
50B Thames St., New York, N. Y.

OAKITE *Certified cleaning*
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

▼ BUSINESS NOTES ▼

EFFECTIVE August 1, C. W. Crumb is appointed Central Division Sales manager for Oliver United Filters, Inc., with headquarters at 221 N. LaSalle Street, Chicago. Crumb has been connected with the company for the past 11 years as sales engineer.

LINK-BELT COMPANY announces that William W. Bond has been appointed western sales manager of the positive drive division, with headquarters at the Dodge plant in Indianapolis, to succeed G. Howard Burkholder, deceased. Bond has been in the company's employ since 1911, first serving in the engineering department at the Philadelphia plant. For the last 15 years he has been engaged in the sale of roller chain drives.

Coincidentally with Bond's promotion, Ralph S. Dyson, for many years manager of stock silent and roller chain drives through distributors, will also head up roller chain sales to duplicate machinery manufacturers. Dyson entered the company employ in 1899.

J. B. O'CONNOR, vice president and director of sales of Clark Bros. Company, Olean, New York, is back at his desk after a vacation with his family in Western Canada. Mr. O'Connor's family are returning to New York from Vancouver Island by steamship, via the Panama Canal.

LILIE-HOFFMAN Cooling Towers, Inc., 4239 Duncan Avenue, St. Louis, Mo., announces appintment of H. E. Hearn, Hako Engineering Company, National Bank of Tulsa Building, Tulsa, as representative for the company for Oklahoma and Eastern Kansas.

BYRON JACKSON COMPANY announce the opening of a branch office of the Pump Division at 407 South Dearborn Street, Chicago, in charge of J. J. O'Connor.

J. J. O'CONNOR

ROBERT J. DAVIS has been elected president of The Johnston & Jennings Company, to succeed Tracy J. Calhoun, who has been elected chairman of the board.

Davis has been a director of the company for the past 2½ years, and is a grandson of the late Robert Johnston of Cleveland, who was one of the founders of the business in 1884.

Hart H. Fleming continues as vice president of the company.

The Oil Conservation Engineering Company, manufacturer of tank fittings and oil industry specialties, was merged with The Johnston & Jennings Company some years ago, and is now operated as the OCECO Division of that company.

ACCORDING to a recent announcement by J. B. O'Connor, vice president of Clark Bros. Company, manufacturers of engines and compressors, Robert R. McCartney is now handling export and eastern coastal sales and engineering matters for the company.

Before joining Clark Bros. in April of this year, McCartney had been associated for a number of years with Gulf Oil Corporation in New York. Prior to that employment he spent 10 years in the pump and engine division of Worthington Pump and Machinery Corporation, after graduating from the Pratt Institute of Mechanical Engineering in 1924. He has headquarters in the New York office of the company.

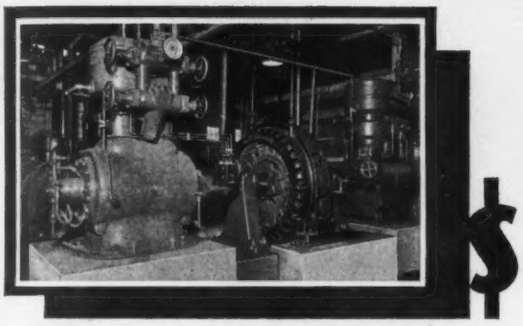
J. W. HERMAN was recently elected treasurer of the Lukens Steel Company, succeeding the late George Thomas, 3rd. Herman joined Lukens in January, 1916, as a clerk in the accounting department and after a year was transferred to the purchasing department as secretary to H. B. Spackman, vice president and purchasing agent.

In June, 1918, Herman joined the U. S. Army, and served in the Ordnance Department at Raritan Arsenal, New Jersey, until his discharge in June, 1919. Returning to Coatesville, he became a clerk in the purchasing department of Lukens for about a year, and was then transferred to the accounting department as assistant auditor.

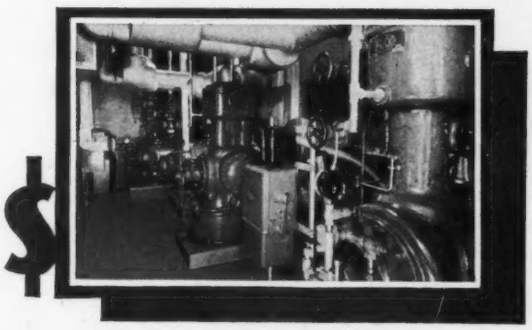
In 1925, the board of directors of Lukens elected Herman assistant secretary and assistant treasurer of the company, in which capacity he served continuously until his election as treasurer.

BYRON JACKSON COMPANY has established a new Pump Division branch office at 703 Gulf Building, Pittsburgh, with Murray Russell in charge. The new branch, situated as it is in the heavy industrial area of western Pennsylvania, will enable the company to render a broader and faster

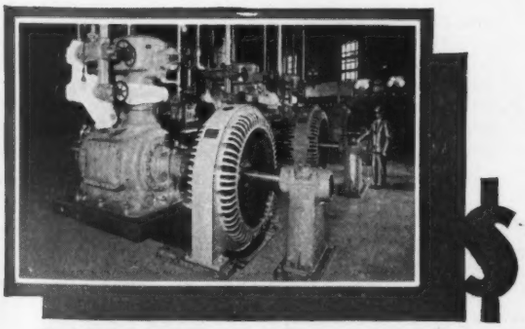
Does Modernizing Pay?



The Seabrook Farms - Deerfield Packing Co. at Bridgeton, N. J., reduced their power cost a third by installing Frick 2-stage compressors.



A 9 x 9 and two 7 x 7 Frick Compressors freeze ice cream in one of seven plants modernized this year with Frick Refrigeration by General Ice Cream Corp., Utica.



Noel & Co. are saving $20,000 yearly in their ice and cold storage plant at Nashville since modernizing with Frick Refrigeration.

Let us show you what modernizing with Frick Refrigeration can do in your plant. A survey will likely reveal facts that will pleasantly surprise you.

Write today to

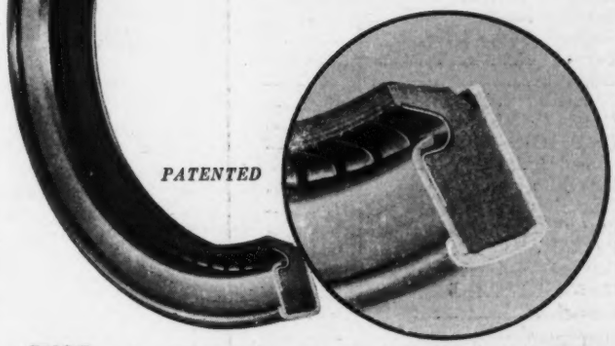
DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.

BE WISE! like the Owl

...Use the OIL SEAL that RESISTS OIL and HEAT



PATENTED

THE Garlock KLOZURE

Hundreds of designing and operating engineers are wise to this superior oil seal. They are using the Garlock KLOZURE under severe conditions and find that it does everything we claim for it—resists oil and water, is unaffected by high temperatures, does not become soft and flabby in service and gives long, uniform performance.

The KLOZURE sealing ring is not leather, cork, felt or fibre. It is made from a compound developed by Garlock especially for oil seal service. This compound is non-porous, non-abrasive, tough and durable. Being inherently resilient, it does not require heavy spring loading.

Write for catalogs!

THE GARLOCK PACKING CO.
Palmyra, N. Y.

Tulsa, Okla.
Houston, Texas
Los Angeles, California

SPLIT-KLOZURE

Dismantling of heavy machinery is unnecessary when installing the new Garlock SPLIT-KLOZURE which is applied around the shaft in the same manner as a packing ring. It is a time- and money-saver. Like the standard solid KLOZURE, the Garlock SPLIT-KLOZURE is furnished in a complete range of sizes.

GARLOCK

KINNEY PUMPS

If YOU pump

LIQUID	V
Asphalt (350-650°F.)	
Asphalt (under 350°F.)	
Asphalt, loaded coating	
Benzol	
Caustic	
Cleaning Solvent	
Crude Oil (heavy)	
Crude Oil (light)	
Diesel Oil	
Distillate	
Emulsion (asphalt)	
Ethyl Chloride	
Fuel Oil	
Furnace Oil	
Gas Oil	
Gasoline	
Grease (hot)	
Grease (semi-solid)	
Hot Oil (still bottoms)	
Hot Oil (heating systems)	
Kerosene	
Lube Oils	
Paraffin (hot)	
Pitch Tar	
Road Oil	
Solvents	
Straw Oil	
Water	

write for Bulletin 16

DISTRICT OFFICES

New York, 30 Church St. — Los Angeles, 1333 Santa Fe Ave.
Dallas, 808 Santa Fe Bldg. — Chicago, 1202 Buckingham Bldg.
Philadelphia, 725 Com. Trust Bldg. — San Francisco, King-Knight Co.

Kinney MANUFACTURING COMPANY
3539 Washington Street
Boston, Mass.

MURRAY RUSSELL

service to pump customers in that territory.

Russell joined the Pump Division of Byron Jackson Company nearly 10 years ago in Detroit, where he handled many large installations of pumps of diverse types. He later transferred to the Bethlehem factory, and from there to the Byron Jackson office in New York. His broad experience in pump applications is expected to prove of benefit both to the trade and the company.

THE Dallas, Texas, district office of Allis-Chalmers Manufacturing Company, of which E. W. Burbank is manager, has been moved to a new location, 1800 North Market Street, where the power, electrical and industrial divisions of the company now occupy an entire building. This three story building houses not only the company's offices but also its warehouse which carries a large stock of Tex-rope belts and sheaves, transformers, motors, starters and pumps. It also has a small machine shop where minor repairs may be made. This building is not occupied by the company's tractor and farm implement division which maintains its own sales and service branch in that city.

WORTHINGTON Pump and Machinery Corporation, Harrison, New Jersey, announces the appointment of Ludwig Emde to the position of Detroit district sales manager. A member of the Worthington organization since his graduation from the University of Michigan in 1930, Emde is well known in the Detroit district. He will succeed William J. Daly, recently transferred to the corporation's Philadelphia office as manager.

J. C. BARNABY, former manager of Worthington Pump and Machinery Corporation's oil and gas engine application division at Buffalo, New York, and responsible for engine sales in the central division, is being placed in charge of special engineering work covering engine research and design,

USE A PACKING THAT HAS MERIT AND LONG LIFE IN SERVICE

PELRO

A packing especially designed for pumps in the oil industry, handling

BUTANE, NAPHTHAS and all Light Stocks

Does not contain glycerine in its lubricating compound.

Does not get hard and avoids overheating and friction on the pump shaft.

Write for Complete A B C Packing Chart

Send for free working samples. State size.

GREENE, TWEED & CO.
Sole Manufacturers
109 DUANE STREET, NEW YORK

Bill says

For Safety Specify KERLOW FLOORS

KERLOW gratings and safety steps are made in all riveted and rectangular types and cut to fit your exact requirements.

For: Subways, boiler room floors, walkways, fire escapes, platforms, areaways, sidewalks, trench covers. KERLOW Bridge Paving (open and solid types).

Ask about Kerlow "BOLDEJ" Safety Steps. —The latest advancement in safety steps.

KERLOW GRATING PRODUCTS

Write for Catalog
Representatives in Principal Cities

KERLOW STEEL FLOORING CO.
Dept. R
210 Culver Ave. Jersey City, N.J.

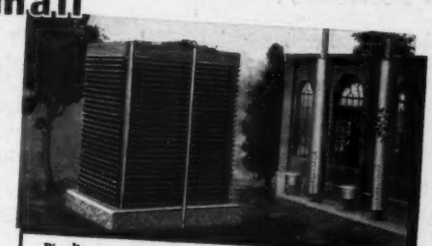
MARLEY Water Cooling Meets Your Exact Requirements

LARGE or Small

Many refineries and natural gasoline plants have proved the value of MARLEY Forced-Draft Towers where absolute dependability, controlled operating flexibility and high heat-reductions are demanded.

Call in a MARLEY Expert

for a thorough study of your cooling problem. His recommendations are based on years of research and the broadest experience in the field. An inquiry costs nothing, incurs no obligation and may result in important savings.



Pipe line pumping stations throughout the nation are served efficiently and economically by small MARLEY Spray Towers like the one above.

The MARLEY Company
Fairfax Road and Marley Ave., Kansas City, Kansas
Sales Offices or Agents in Principal Cities

ROTO DICTATOR TUBE CLEANER

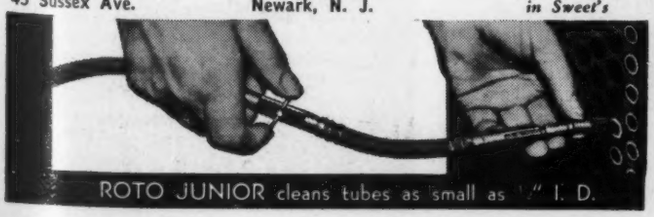
FAST RUGGED POWERFUL

Saves Up to 66% on Down Time

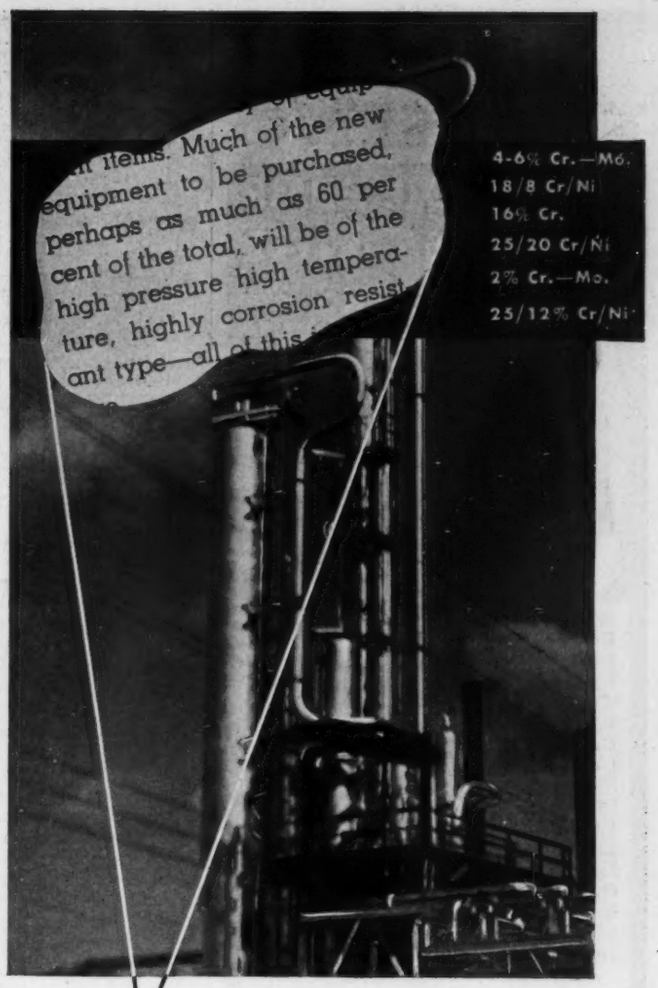
WRITE FOR DETAILS

The ROTO Company
45 Sussex Ave. Newark, N. J.

See Our Adv. in Sweet's



ROTO JUNIOR cleans tubes as small as ¾" I. D.



PROGRESS **in alloy welding in the refinery industry has been accelerated by the research work of Arcos Corporation.** ***Weld deposits*** **from Arcos Chromend Electrodes are not only excellent in physical properties; they also assure a weld highly resistant to heat and corrosion.**

Tons of Arcos Stainless Electrodes have gone into the fabrication of equipment for leading refiners the country over.

Specialization by Arcos in the chrome and chrome-nickel analyses has made available rods to conform to your most rigid requirements.

STAINLESS ELECTRODES

ARCOS CORPORATION

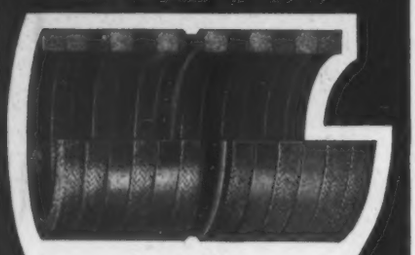
DEPT. A 401 NORTH BROAD ST., PHILA., PA.

PIONEER OF STAINLESS STEEL ELECTRODES IN U. S.

Arcos Technical Bulletins are widely acknowledged as valuable contributions to the science and practice of alloy welding. Bulletin No. 3 is on the press. Write for your copy today.

A GOOD PACKING

for HOT OIL PUMP STAINLESS STEEL PLUNGERS



Style 1011

Recommended for use on stainless steel and cold rolled steel medium hard rods and plungers of high pressure, high temperature hot oil pumps.

"John Crane"

Style 1011

PACKING

...consists of braided jacket over jacket asbestos yarns treated with Craneprene (our exclusive oil and gasoline proof binder), alternated with semi-metallic rings of oil-proof plastic asbestos.

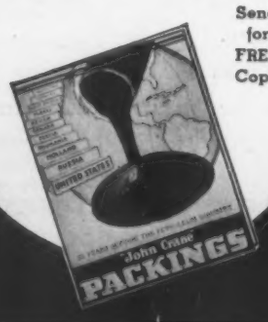
Eliminate your hot oil pump packing worries with this new "John Crane" product — it's not affected by hot oils or high speeds.

CRANE PACKING CO.

1804 CUYLER AVENUE

CHICAGO, ILLINOIS

Send for FREE Copy



CRANE PACKING COMPANY
1804 Cuyler Ave., Chicago, Ill.
Please send Bulletin on PETROLEUM SERVICE PACKINGS.

Name_____

Company_____

Address_____

City_____ State_____

and will devote his entire time to this activity.

W. E. Wechter, in charge at New York of the corporation's engine sales in the Atlantic division, has been transferred to Buffalo to succeed Barnaby. He will be assisted by J. F. Hecking, who continues in his present capacity of assistant manager of the oil and gas engine application division.

In the Atlantic division, oil engine sales will be covered by H. C. Wood at New York, while W. L. Russell, at Harrison, New Jersey, will take over the gas engine sales. This latter assignment is in addition to Russell's present responsibilities as manager of the Eastern Division of Worthington oil and gas power sales.

Desalting Crudes Presents Two Problems

THE general problem of the determination of salts in crude oils comprises, in reality, two entirely separate and distinct problems," according to C. H. Roberts and R. W. Stenzel in an article entitled "Determination of Salts in Crude Oils," parts one and two of which have appeared in recent issues of The Electric Dehydrator, published by Petroleum Rectifying Company of California. The first of these consists of the complete extraction from the oil, by suitable means, of the salts contained therein; while the second problem comprises the estimation, in the aqueous extract, of the kinds and quantities of the various substances present. As will be appreciated, the first problem is by far the more difficult of the two and is the one which has engaged the attention of analysts to the greater degree, as is evidenced by the variety of procedures that have been proposed for its solution.

"The reason for the emphasis which has been placed upon this phase of the general problem is due, first, to the difficulties of extraction processes in heterogeneous systems and, second, to the fact that crude oils contain naturally occurring emulsifying agents, whose presence hinders solution of the salts in the extraction medium and impedes its complete separation and recovery for subsequent analysis. The second problem, that of the estimation of the materials extracted from the oil, is relatively simple; involving only the principles and practices of water analysis, which are well known and more or less highly standardized."

The article referred to continues the discussion with summaries of methods for extraction of salts from crude and methods for analysis of aqueous extract. The third and concluding part of the article deals with Analytical Methods and appears in the August issue of The Electric Dehydrator.

Complete copies of these issues are available from the Petroleum Rectifying Company of California, 714 Security Title Insurance Building, 530 West Sixth Street, Los Angeles, Calif. The research work is especially valuable where the problem involves salt water emulsions.

OIL BOOKS

The knowledge gained through years of work and study by some of the most capable men in the oil industry is set down in the various oil books published and sold by the Gulf Publishing Company. Catalog of these books furnished upon request.

THE GULF PUBLISHING CO.
P. O. Box 2811 **Houston, Texas**

Manufacturer of well known line pipe fittings is seeking services of Texas-Gulf Coast representative with knowledge of refinery piping practices as well as following in engineering and purchasing departments in this area. To travel states of Texas and Louisiana with headquarters at Houston. Write briefly your qualifications and state remuneration desired. Box 222, The Refiner, Houston, Texas.

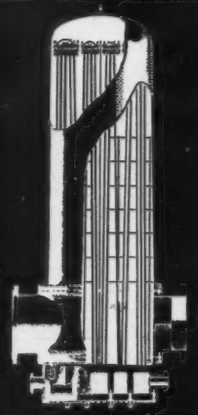
SALES REPRESENTATIVE

Capable Refinery Engineer with over ten years experience in sales engineering available for Direct Sales or Special Representation for first line Companies in the Gulf Coast and Mid-Continent areas. Excellent contacts and references.

Box 101 **30 Rockefeller Plaza,**
Suite 1221 **New York City**

LEACH FRACTO CONDENSERS

for High Pressure and Temperature.



Also Heat Exchangers for Vacuum and Atmospheric Service.

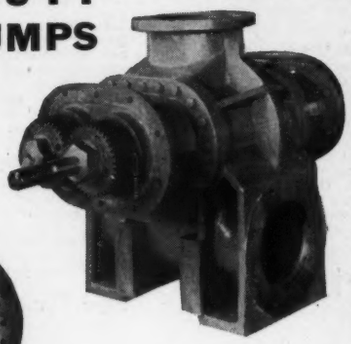
Fracto Control

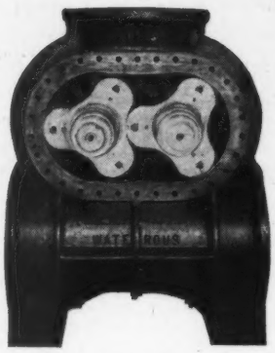
Patented in the United States and Foreign Countries.

C. H. LEACH CO., Inc.
117 Liberty Street, New York, N. Y.

WATEROUS

HEAVY DUTY ROTARY PUMPS are fully adjustable for wear



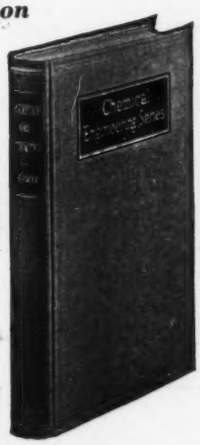


AFTER YEARS of service internal wear may be easily compensated, without removing pump from its mountings or disturbing pipe connections.

WATEROUS COMPANY

St. Paul, Minnesota
Established 1886

Here's help in the design and operation of absorption and extraction equipment.



ABSORPTION and EXTRACTION

By THOMAS K. SHERWOOD

Associate Professor of Chemical Engineering, Massachusetts Institute of Technology

278 pages — 91 illustrations — $3.50

This book outlines the underlying theory of such important diffusional processes of the unit operations of chemical engineering as absorption, extraction, drying, humidification, and dehumidification. Particular attention is given to the engineering problems connected with the design and operation of equipment for absorption and extraction.

Special Features:

- —chapters on absorption of multi-component mixtures and on solvent extraction.
- —treatment of equilibria in liquid-vapor systems of mixed hydrocarbons.
- —method of calculation used in the design of absorbers for natural gasoline and refinery gases.
- —outline of the general procedure and treatment of petroleum problems.

SEND CHECK TO

GULF PUBLISHING COMPANY

P. O. BOX 2811 HOUSTON, TEXAS

Now we Simplify with Anderson SUPER-SILVERTOPS

"In the past we used to use old style traps with complicated piping. Now we simplify our steam trap piping with Anderson Super-Silvertops at a real saving in fittings and labor. This Super-Silvertop type makes the old type trap obsolete. Here's why. You can see the saving in fittings by comparing those two traps up there—that's one reason. The traps can be inspected right on the line at a saving in maintenance time—that's another reason. The extra capacity is a reserve for any heavy, unforeseen load.

"With all those advantages, we pay no more for the trap than we would for any other make. Do you wonder that we decided to change? It was a case of much to gain and nothing to lose."

Each Anderson Super-Silvertop trap is backed by 54 years of steam trap manufacturing experience. Constant research through these years is responsible for the reliability and long life of each Anderson trap.

Find out for yourself what this trap can do. Write today for complete details about saving by simplifying with Anderson Super-Silvertops.

THE V. D. ANDERSON CO.
1942 West 96th Street • Cleveland, Ohio

Anderson **SUPER-SILVERTOP**

CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Alloys

The International Nickel Company, 67 Wall Street, New York, has issued an interesting booklet, "6 Minutes with 6 Metals," which includes the characteristics and uses of the special alloys such as Inconel, "K," "S" and "R" Monel as well as the more generally known Monel and Nickel.

Regulators

Mason Neilan Regulator Company, Boston, Mass., has released a new 44-page bulletin, No. 3010, which describes in detail its line of pressure recorders and recording and indicating thermometers. The bulletin is illustrated and contains much data to aid in the selection of the proper instrument for the job. Featured are the floating coil movement and the exclusive overheat protector for vapor-pressure thermometers.

Testing Equipment

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has published and eight-page illustrated pamphlet on field and truck type outfits for testing oil. The dielectric strength of insulating oils in transformers, circuit breakers, switches and any other oil insulated apparatus may be determined quickly and accurately by means of these portable instruments. The catalog describes the operation of high-voltage testing equipment to be used in cable testing. Each type of equipment is illustrated and tables include list prices and styles.

Metals

Alan Wood Steel Company, Conshohocken, Pa., has published a new booklet entitled "A. W. Present Dyn-El," which describes a new high strength, flat rolled steel with unusual resistance to fatigue, impact and corrosion.

Expansion

E. B. Badger & Sons Co., Boston, Mass., has published a new Bulletin No. 200 which illustrates and describes briefly various kinds of Badger packless expansion joints, the history of this type of joint, improvements brought about by the company, uses, list prices, dimensions and weights of the Badger copper and stainless steel non-equalizing expansion joints. Also available is bulletin No. 300 on Badger Pipe Line Flexible Seals, for sealing pipes through formations and walls.

Electrical Equipment

General Electric Company, Schenectady, N. Y., has recently published the following new literature: Gea-19H- A-c Magnetic Motor Starting Switch, Cr7006 D 7; Gea-743B- A-C reversing drum switches, CR 3202; GEA-1750D- Alternating Current Arc Welders, Type Wk; GEA-2234B- Manual Motor-Starting Switches; GEA-2292A-D.C. Magnetic Crane Controls; GEA-2679 A- G-E Photoelectric relay for automatic light control; GEA-2907-Alnico Limit Switches; GEA 2908- New Oilproof Push Button and Selector Switches; Gea-1524C- Type B Direct-Current Motors; Gea-2889, Magnetic Motor Starting Switches; GEA-2052 A- New Track Type Limit Switches; GEA-67E- Float Switches for use with automatic pumping equipment for water level control; GEA-2571B, Reconditioning Flooded Electric Equipment; GEA-1607B-, Direct Current Generators and Exciters; GEA-1437C- General Electric Gear Motors.

Weld Fittings

Bonney Forge & Tool Works, Allentown, Pa., has published Bulletin No. WT28, describing Bonney Weldolets and Thredolets, welded outlets for piping. In addition to describing the drop forged welding fittings, additional advantages of the fittings are discussed. A graphic illustration of the economies that can be effected through the use of these fittings is given, as well as completed tables of sizes in which they are available from stock, dimensions, weights and list prices are given. Numerous illustrations show the many types of installations on which they have been used.

Recording and Controlling Instruments

C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, has published catalog 1060D, a new 64-page book entitled "Tag Indicating, Recording and Controlling Instruments for Temperature and Pressure." It is more than a regular listing catalog for it presents information in a clear manner on the latest Tag instrument developments. In addition to the new line of Recording thermometers and recording pressure gages with 10- and 12-inch charts, complete data is presented on indicating and recording controllers. The control instruments are listed in either the "on-off" model for all ordinary control applications, or the throttling model for use where any considerable apparatus lag is encountered. Many illustrations show how these instruments operate and installation photographs tell the story of what they are doing for the process industries.

Refractories

United States Stoneware Company, 60 East 42nd Street, New York, has published Bulletin 1200 describing Vitriram plastic refractory material and Vitricast castable refractory materials, and gives instructions for their use. Vitriram is used for making monolithic linings in furnaces, kilns, boiler settings, etc., and in patching work. Vitricast is an hydraulic setting, castable refractory material which is applicable for furnace hearths, and the like.

Controls

Frick Company, Waynesboro, Pa., has published Bulletin No. 201-C, dealing with Frick float valve controls and automatic regulation of the refrigerant feed in cooling systems. The bulletin is well illustrated with photographs and diagrams, and the text presents all pertinent information.

Circuit Breakers

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has published Descriptive Data 33-675, a 12-page booklet describing Type "U" De-ion air circuit breakers, designed for indoor service especially in generating and industrial plants where reliability under severe operating duty and minimum space is of importance. The breakers are applicable to standard voltage ratings from 2500 to 15,000 volts, and are furnished in standard current ratings of 600, 1200 and 2000 amperes.

Pumps

Lawrence Pump & Engine Company, Lawrence, Mass., has published Bulletin D-48, presenting completed engineering and pictorial information on its new line of Type "HBD" Lawrence Vortex centrifugal pumps, which are single-stage, side-suction centrifugals for general industrial use. They are furnished in sizes from 1½- to 18-inch discharge; in capacities from 10 to 15,000 gallons per minute and with heads up to 300 feet for the smaller sizes.

Steam Equipment

Yarnall-Waring Company, Chestnut Hill, Philadelphia, Pa., has published Bulletin G-1304 which is a newly revised edition of its condensed folder on the Yarway line of steam plant equipment. The 12-page bulletin is well illustrated and contains all engineering information pertinent to the subject.

Pipe Hangers

Grinnell Company, Providence, Rhode Island, has published "A Grinnell Adjustable Pipe Hanger Chart," which pictorially presents a wide line of adjustable pipe hangers and supports.

Welding Rods

Metal & Thermit Corporation, 120 Broadway, New York, announces a new edition of its pocket size catalog on Murex welding rods. Considerably revised and enlarged, the new issue contains brief data on the physical properties and chemical analysis of the weld metal deposited by each of the twenty odd electrodes in the Murex line. Included are individual, specially designed electrodes for high-speed, downhand welding of mild steel, for all position welding; for horizontal fillet work, for welding manganese, carbon-molybdenum and nickel steels; for several of the stainless steels; and for a number of the new high-strength, low-alloy steels.

Engine

Worthington Pump and Machinery Corporation, Harrison, New Jersey, is distributing Bulletin S-550-B14, describing the latest addition to the company's extensive line of gas engines. To be known as Type LPE, the new engine is of the vertical four-cycle design, a power unit arrangement of the company's LCE gas engine compressor unit. The units are available in 4, 6, and 8-cylinder arrangements, conservatively rated at 180, 270 and 360 horsepower when running at 400 r.p.m. The engine is of the multi-cylinder, trunk piston type with cylinders of the L-head design arranged in line. The entire unit is totally enclosed and has full circulating pressure lubrication throughout.

Recorders

The Bristol Company, Waterbury, Conn., is distributing Bulletin No. 510, illustrating a modern installation of Bristol's machine-operation recorders. Some of the helpful information provided by these instruments is indicated by the following: cutting or running time of the machine, delay time, idle time, set-up or make-ready time, quantity and rate of production.

Refractories

Plibrico Jointless Firebrick Company, 1800 Kingsbury St., Chicago, has published a new 40-page edition of the catalog "Plibrico Furnace Construction for H.R.T. Boilers," covering the subject of boiler setting construction and refractory linings for horizontal return tubular and other types of fire tube boilers. A considerable section is devoted to air-cooling, modernization of existing settings, and principles of furnace design.

Oxygen Breathing Apparatus

Mine Safety Appliances Company, Pittsburgh, Pa., has published Bulletin Bm-2, describing the M.S.A. 1-Hour Oxygen Breathing Apparatus, in which the principle of operation and fields of use are clearly set forth. Designed for complete respiratory protection in atmospheres containing concentrations of gases too high for safe use of canister-type masks or where oxygen content is below the minimum necessary to support life, the U. S. Bureau of Mines-approved, One-hour apparatus is shown in both mouthpiece and facepiece types, as well as with the M.S.A. speaking diaphragm facepiece which permits easy voice communication between men in gas- or smoke-filled areas.

Union Line Blinds

Hamer Oil Tool Company of Texas, 4820 Travis St., Houston, has published a new illustrated complete catalog and price list. The bulletin pictures and describes the new Hamer Union Line blind for quick and positive shut-off, and the Hamer line of lubricated stop cocks and plug valves, and other products. The catalog presents in detail all pertinent engineering information.

USE THIS COUPON

.....
MANUFACTURER'S NAME

.....
MANUFACTURER'S ADDRESS

Please send me, without obligation, free booklet described in September, 1938, issue of THE REFINER AND NATURAL GASOLINE MANUFACTURER.

NAME.....

ADDRESS.....